Japan's Action Report on Climate Change

The Government of Japan

1994

Notice

In responding to the request of the Secretariat of the United Nations Framework Convention on Climate Change for publishing the CD-ROM version of the First National Communication of Annex-I parties to the convention, which will be distributed at the third Conference of the Parties, Environment Agency of Japan releases this electric version of the First National Communication of Japan in November 1997.

Since the electric information of original version of the Communication was lost, an attempt to restore the contents of the Communication including tables and graphics was made by Environment Agency of Japan. The attempt was successful and all of the information was restored.

Basically all of the contents is the same as that of the original version of the Communication published in September 1994, although the appearance of text and graphics of this version is not entirely the same as the original version.

It is hoped that the content of our First National Communication will electrically be accessible to international society addressing to climate change issues.

November 1997
Environment Agency of Japan
Tokyo

Contents

Executive Summary

I. Japanese Context

Japan is an archipelago stretching approximately from 24 degrees to 46 degrees north latitude. Its territory as of 1990 extends over 37,770,000 hectares, or about 0.3 percent of the earth's land area. Japan's population of about 123 million is 2.5 percent of the world population. Its gross domestic product was about \433 trillion (US$ 2,958 billion) in 1990. About 67 percent of Japan's land is covered by forests. Japan's climatic zones range from subtropical to subarctic, with four sharply distinct seasons. The long-term rate of increase in Japan's average annual temperature is currently estimated to be 0.9 degrees Celsius per 100 years.

Japan is dependent on foreign sources for most of the energy that produces the greater part of its carbon dioxide emissions. Though this dependence has been reduced somewhat by introducing oil substitutes in recent years, it remains slightly above 80 percent, leaving Japan highly exposed to the effects of supply fluctuations. Final energy consumption increased substantially throughout the period of rapid economic growth of the 1960s (during which real annual economic growth averaged 10.3 percent), but since the first oil crisis energy consumption has tended to remain level or to sink: the ratio of unit energy to unit GNP in fiscal 1990 was 36 percent less than in fiscal 1973. Japan's per capita energy consumption is therefore extremely low by advanced industrialized nations' standards, the equivalent of about 4,250 liters of oil per annum. Broken down, energy consumption was increasing considerably in the industrial, commercial/residential, and transport sectors of the economy until the first oil crisis; from 1973 until 1986, consumption tended to continue to increase in the commercial/residential and transport sectors, whereas consumption levels generally continued to decline in Japanese industry, which had accomplished a structural conversion to low energy consumption and the world's most advanced high-energy-efficiency technology. All three sectors tended to increase energy consumption as long as the economy remained strong after 1986; energy consumption continued to grow especially in the commercial/residential and transport sectors even after the economy began an adjustment phase in mid 1991, but in industry, it declined.

In short, although total emissions have continued to increase over the past few years, per capita carbon dioxide emissions are lower, thanks to Japan's generally temperate climate, relative geographical exiguity, and advanced economy, in addition to efforts to reduce energy consumption since the first oil crisis and greater resulting energy efficiency.

II. National Inventory of Greenhouse Gas Emissions and Removals

1. Basic approach

This greenhouse gas emissions and removals inventory was compiled in accordance with the following approach based on the Guidelines for the Preparation of First Communications by Annex I Parties.

An inventory was compiled for emissions of carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O); and precursors: other nitrogen oxides (NOx), carbon monoxide (CO), and non-methane volatile organic compounds (NMVOC) during fiscal 1990 (April 1990-March 1991). Removals of carbon dioxide were also calculated.

Total greenhouse gas emissions and removals were calculated generally by the methods explained in

the IPCC/OECD Draft Guidelines. That is, to quantify greenhouse gas emissions and removals in each sector, activity data on fuel consumption or other relevant values were multiplied by an emission factor for each gas emitting source and a removal factor for each sink. Significant figures were considered in the calculations. To calculate nitrogen oxide emissions, total measured nitrogen oxide emissions from all soot and smoke emitting facilities controlled under the Air Pollution Control Law were summed.

Currently, emission/removal factors and activity data needed to estimate emissions and removals are insufficient in certain categories. Improvement in these fields will be possible as more information is acquired and as international trends develop.

2. National inventory of greenhouse gas emissions and removals

Table 2-1 contains Japan's fiscal 1990 greenhouse gas emissions and removals inventory.

Table 2-1 National Greenhouse Gas Inventory in Fiscal 1990

(unit: Gg)

Greenhouse gas source and sink categories	CO2	CH4	N2O	NOx	CO	NMVOC
Quality (confidence in estimation)	High	Medium	Low	High	Low	Low
Total National Emissions	1,173,000	1,380	48	1,898	2,809	2,060
I.All Energy (Fuel Combustion + Fugitive)	1,075,000	125	22	1,844	2,792	560
A. Fuel Combustion	1,075,000	25	22	1,844	2,792	340
Energy & Transformation Industries	82,000	2	5	388	126	40
Industry (including Agriculture/Forestry)	489,000	8	4	393	306	20
Commercial/Institutional	123,000	0.5	NE	16	5	NE
Residential	139,000	0.5	0.1	38	25	NE
Transport	215,000	14	13	1,009	2,330	280
Other	9,000	NE	NE	NE	NE	NE
Biomass Burned for Energy	18,000	NE	NE	NE	NE	NE
B. Fugitive Fuel Emissions	NE	100	NE	NE	NE	220
Oil and Natural Gas Systems	NE	NE	NE	NE	NE	220
Coal Mining	NA	100	NA	NA	NA	NE
II. Industrial Processes	53,000	NE	15	1	NE	60
A. Chemicals	NE	NE	15	1	NE	60
B. Non-metallic Mineral Products	43,200	NE	NE	NE	NE	NE
C. Other	9,800	NE	NE	NE	NE	NE
III. Solvent Use	NE	NE	NE	NE	NE	1,440
IV. Agriculture	NE	790	5	NE	NE	NE
A. Enteric Fermentation	NA	330	NA	NA	NA	NA
B. Animal Wastes	NA	190	NA	NA	NA	NA
C. Rice Cultivation	NA	261	NE	NA	NA	NA
D. Agricultural Soils	NA	NE	4	NA	NA	NA
E. Agricultural Waste Burning	NA	6	1	NE	NE	NE
F. Savanna Burning	NA	NA	NA	NA	NA	NA
V. Land Use Change & Forestry	IE*	NE	NE	NE	NE	NE
A. Forest Clearing & On-Site Burning of	NE	NE	NE	NE	NE	NA
Cleared Forests						
B. Grassland Conversion	NE	NA	NA	NA	NA	NA
C. Managed Forests	IE*	NA	NA	NA	NA	NA
D. Abandonment of Managed Lands	NE	NA	NA	NA	NA	NA
VI. Waste	45,000	465	6	53	17	NE
A. Landfills	1,000	446	NA	NA	NA	NA
B. Wastewater	NA	6	NE	NA	NA	NA
C. Other	44,000	13	6	53	17	NE
International Bunker Oil	31,000	NE	NE	NE	NE	NE
Total Removals (Managed Forests)	90,000	NA	NA	NA	NA	NA

Code Meaning
NA = Not applicable
NE = Not estimated
IE = Estimated but included elsewhere
* = Estimated taking into account removals in sink data

III. Policies and Measures

In October 1990 the Japanese government established an Action Program To Arrest Global Warming by decision of the Council of Ministers for Global Environment Conservation. This Action Program spells out the government's current orientation in the short term and the general framework of enforceable measures that it should take in the future to promote planned and comprehensive measures against global warming; it also clarifies its basic approach toward obtaining the Japanese people's understanding and cooperation as well as contributions within the international framework. The Action Program is the national program of Japan provided for in Article 4 paragraph 1(b) of the United Nations Framework Convention on Climate Change.

The Action Program defines the formation of an environmentally sound society, the harmonization of environmental protection with stable economic development, and international coordination as "basic elements" of efforts to counteract global warming; it sets the year 2000 as its interim target year and the period until 2010 as its duration. Its targets are defined below:

(1) The Government of Japan, based on the common efforts of the major industrialized countries to limit CO_2 emissions, establishes the following target for the stabilization of Japan's CO_2 emissions.

a) The emissions of CO_2 should be stabilized on a per capita basis in the year 2000 and beyond at about the same level as in 1990, by steadily implementing a wide range of measures under this Action Program, as they become feasible, through the utmost efforts by both the government and private sectors.

b) Efforts should also be made, along with the measures above, to stabilize the total amount of CO_2 emission in the year 2000 and beyond at about the same level as in 1990, through progress in the development of innovative technologies, etc., including those related to solar, hydrogen and other new energies as well as fixation of CO_2 at the pace and in the scale greater than currently predicted.

(2) The emission of methane gas should not exceed the present level. To the extent possible, nitrous oxide and other greenhouse gases should not be increased.

With respect to sinks of CO_2, efforts should be made to work for the conservation and development of forests, greenery in urban areas and so forth in Japan and also to take steps to conserve and expand forests on a global scale, among others.

The Action Program also puts the following measures on the government agenda: measures to limit CO_2 emissions; measures to reduce the emissions of methane and other greenhouse gases; measures to enhance carbon dioxide sinks; promotion of scientific research and observation/ monitoring; the development and dissemination of technology and the promotion of public awareness; and international cooperation.

The Action Program's implementing framework consists of annual followup by the Council of

Ministers for Global Environment Conservation to review progress toward implementation and the latest data on carbon dioxide emission levels.

The Council of Ministers has also decided to issue an appeal to the world community regarding the need for planning of long term vision to meet global warming ("The New Earth 21").

In November 1993 the Japanese Diet enacted the Basic Environment Law Japan's new law on the environment establishes as basic principles first, the enjoyment and perpetuation of the blessings of a healthy environment, second, the creation of a society ensuring sustainable development with reduced environmental load, and third, active promotion of global environmental conservation through international cooperation. It establishes a Basic Environment Plan in which the Action Program To Arrest Global Warming will be appropriately incorporated, it specifies measures that the national government must take, including surveys and research related to economic measures, and it provides for international cooperation for global environmental protection.

1. Measures to limit carbon dioxide emissions

1.1. Industry

In industry, which accounts for about half of Japan's carbon dioxide emissions, the development of energy-saving technology has been promoted under the Energy Conservation Law since the first oil crisis; measures have been taken to improve and better apply standards related to the rationalization of fuel combustion and to assist investments in energy-saving capital equipment through special taxation measures and low-interest financing.

Through these measures, energy use has become more efficient, and marked improvements have been made in energy consumption per mining and industrial production unit. The major energy-saving investments are now already productive; the Energy Conservation Law was amended to effect further energy savings, and the Energy Conservation and Recycling Assistance Law, enacted in 1993, has radically strengthened policies by providing very low interest financing and other incentives for related capital investments.

Japan is also studying energy conservation measures aimed at the use of types of energy yet untried in agriculture, forestry and fisheries, and construction. The government is also urging manufacturers to set their own objectives for reducing carbon dioxide emissions.

1.2. Residential and commercial

Energy consumption is tending to rise in both the residential and the commercial/institutional sectors, due to advances in office automation and the wider use and growing capacity of electric home appliances. The following measures are being taken in the residential/commercial sector: i) standards related to insulation in construction are being improved and more strictly applied under the Energy Conservation Law and steps are being taken to assist builders through extra financing, etc., ii) Energy Conservation Law standards for home appliances, etc., are being strengthened and

their scope expanded, iii) the utilization of waste heat and other yet-unused forms of energy is being promoted through low-interest financing, etc., iv) demand for energy for cooling is being curbed through measures to mitigate the heat island phenomenon by planting more greenery in urban areas, and v) the planning of cities that emit little carbon dioxide is being promoted using subsidies from the national treasury and other means.

1.3. Transport

Motor vehicles account for a large and growing proportion of energy consumed to transport both passengers and freight. The following measures are therefore being directed at the transport sector: i) carbon dioxide emissions from motor vehicles are being curbed by setting and strengthening standards (as of 1993) related to gasoline engine passenger cars under the Energy Conservation Law and by using national treasury subsidies, special taxation measures, etc., to promote the introduction of low-emission vehicles, ii) the efficiency of freight transport is being increased by improving services and promoting the use of railway and coastal shipping using interest-free loans, special taxation measures, etc., and by promoting consolidated cargo transportation for intracity distribution, iii) the use of public means of transportation in passenger traffic is being promoted by increasing railway transport capacity and stimulating bus transportation, etc., and iv) transportation systems that generate less carbon dioxide are being created by improving transportation infrastructure to facilitate motor vehicle traffic based on the 11th Five-Year Road Improvement Plan (1993) and the 5th Specific National Five-Year-Project for Traffic Management Systems Installation (1991).

1.4. Energy conversion

In order to use energy more efficiently and to build an energy supply structure that generates little carbon dioxide, Japan is promoting the development of technology (for solar and other new and recycled forms of energy and fuel cells and other new supply systems based on the Basic Plan for Energy Research and Development); and intending to improve the efficiency of power generation by thermal power plants and to promote energy sources such as nuclear power, LNG, and hydropower that generate less or no carbon dioxide. Japan is taking measures to support development in these fields through low-interest financing and special taxation measures.

1.5. Cross-over sector

As measures to realize an environmentally protective lifestyle that overlap multiple sectors, Japan is setting goals, standards, etc., by Recycling Law, promoting recycling through various supportive measures, increasing awareness of environmental protection through the use of environmental marks, and promoting the use of more appropriate packaging.

2. Measures to enhance carbon dioxide sinks (changes in land use and forests)

Japan has long had a large percentage of forested land and has maintained this high percentage. Difficulties stemming from depressed wood prices, increased wood-product imports, etc. in the forest and wood industries are, however, visibly exerting effects on forestry management in some areas. Japan is therefore seeking i) to establish Forest Plans under the Forest Law and to promote planned forest conservation and improvement through the adequate management of Protection Forests, afforestation, and the thinning of forests, ii) to promote the effective use of wood resources, iii) to suitably protect forest that is a foundation for Japan's natural environment through such measures as the designation of nature conservation areas, and iv) to conserve and manage greenery in urban areas through a variety of beautification programs.

3. Measures to reduce methane emissions

3.1. Waste management

About one-third of Japan's methane emissions is generated by waste landfills. Intermediate treatment and recycling are now reducing the volume of waste ultimately in landfills, but waste emissions are on the increase. The following measures are therefore being promoted to improve waste management: i) the Waste Treatment Law was amended in 1991 to encourage people to reduce and recycle waste, ii) treatment facilities are being constructed with the aim of reducing landfill volume, and iii) treatment plants are being converted to types that generate less methane. Japan is also taking steps to curb the consumption of fossil fuels through more efficient use of power generated from waste and other uses of heat from waste incineration.

3.2. Agriculture

Measures to reduce methane emissions in agriculture are still at the research stage; studies are underway to find ways to reduce the methane generated by rice cultivation and by livestock through enteric fermentation.

3.3. Energy Supply and Other Sectors

Efforts are being made to use the gas obtained during coal mining as fuel and legally to prohibit leaks during natural gas development and fugitive gas from gas works.

4. Measures to reduce nitrous oxide emissions

Japan is conducting surveys and research and developing technology with the object of quantitatively determining the amounts of nitrous oxide generated and emitted in manufacturing, agriculture, and waste management and introducing measures to reduce emissions.

5. Measures to reduce emissions of other greenhouse gases

Regulatory measures have been written into the Air Pollution Control Law to systematically deal with nitrogen oxides, carbon monoxide, and non-methane volatile organic carbons. The Japanese Government has established environmental standards for maximum levels of nitrogen oxides and carbon monoxide that should not be exceeded from the standpoint of protecting human health and has set concentration guidelines for the achievement of environmental standards for photochemical oxidants that in effect regulate levels of non-methane volatile organic carbons. Factory, workplace, and motor vehicle emission regulations are being enforced with regard to nitrogen oxides, and financing and special taxation measures are carried out to encourage the building of soot and smoke treatment facilities.

6. Promotion of Public Awareness

Japan has improved its environmental guidance in the Courses of Study (the Ministry of Education's official guidelines for teachers) in addition to promoting environmental protection, resource and energy conservation, and greening campaigns through public relations and the setting of campaign periods in newspapers and other media. In order to promote environmental protection activities by private organizations, a jointly funded government and private-sector Japan Fund for Global Environment was established in 1993. Finally, "Guidelines for Environmentally Sound Corporate Practices" and other manuals and guidelines are being drafted and distributed.

7. Scientific research, observation and monitoring

Scientific research, observation and monitoring, and development of technology related to global environmental problems are being conducted in the framework of two plans: the annually drafted Comprehensive Promotion Program for Global Environment Research, Monitoring and Technology Development and a long-term plan, the Basic Plan for Research and Development Related to Earth Science and Technology (1990). The Comprehensive Global Environment Research Promotion Budget and others have been established to integrate and complement surveys and studies related to global environmental protection. In particular, Japan is promoting regionally extensive observation and monitoring, and surveys and research involving participation and tieups with international groups for planning of global environmental research, observation and monitoring.

8. Promotion of international cooperation (including funding & technology)

Harmony between the environment and development was stated to be one of the principles of ODA (Official Development Assistance) in the ODA Charter, adopted by the Cabinet in 1992. Based on the Prime Minister's announcement at the UNCED, Japan endeavors to significantly expand its ODA in the field of the environment to around \900 billion to \1 trillion during the five-year period starting from fiscal 1992. The Basic Environment Law also stipulates that Japan will promote international cooperation and other efforts directed at global environmental protection.

Specifically, Japan's contributions include $48.20 million (as of March 31, 1994) to the GEF core

fund, human and budgetary contributions to the IPCC, the holding since 1991 of regular regional seminars to integrate promotion in the Asian-Pacific region of measures to arrest global warming and other comprehensive support for efforts to prevent global warming, the establishment of centers to provide information about environmental protection technology and transfers of energy-saving technology, support for the conservation and afforestation of tropical rain forests for the creation of carbon dioxide sinks, international cooperation to efficiently promote environmental and energy technology development, subsidies for NGOs, and support of private-sector international cooperation through the Japan Fund for the Global Environment.

IV. Projections of the Effects of Greenhouse Gas Countermeasures

The projections of the effects of greenhouse gas countermeasures described here target the fiscal year 2000 (April 2000 to March 2001). The greenhouse gases considered in these projections are carbon dioxide, methane, and nitrous oxide. The Projection of the effect of measures to enhance greenhouse gas sinks target carbon dioxide.

1. Carbon dioxide emissions

1.1. Projection and evaluation of carbon dioxide emissions in fiscal 2000

Projections of "Energy (Fuel Combustion)" sector, which accounts for a large proportion of carbon dioxide emissions, are based on the energy supply and demand outlook for fiscal 2000 in the "Long-Term Energy Supply and Demand Outlook" published by the Advisory Committee for Energy. The "Outlook" is based on assumed economic growth rate and the price of oil (see the notes below) and assumptions that efforts by all concerned parties
will ensure that all energy-conservation measures taken since fiscal 1990 and new energy-conservation measures foreseeable as of fiscal 1994 will make an expected contribution to lower carbon dioxide emissions.

Total carbon dioxide emissions in fiscal 2000 resulting from those existing and new energy-conservation measures taken into account in the Long-Term Energy Supply and Demand Outlook are estimated to be about 330 million tons of carbon (Table 3-1).

On a per capita basis, this indicates emissions of about 2.6 tons of carbon per year in fiscal 2000; compared with the level actually calculated in 1990 (2.59 tons of carbon per year), this means that the first target of the Action Program cited above is estimated to be achievable.

Yet greater efforts will be necessary, however, to achieve the Action Program's second target of maintaining total carbon dioxide emissions at the 1990 level, since total emissions are estimated to increase with respect to the fiscal 1990 total of 320 million tons of carbon.

Notes:

Economic growth rates:

For fiscal 1991-1994: actual rates through 1993 and from the Economic Outlook and Basic Policy Stance (1994).

For fiscal 1995-2000: 3.5% per annum, the rate assumed in the current economic plan "The Five-Year Economic Plan---Sharing a Better Quality of Life around the Globe." (fiscal 1992-1996), and its exploitations

Oil Price:

US$20 per barrel in fiscal 2000 (equivalent to current oil price in real term)

Table 3-1 Carbon Dioxide Emissions in Fiscal 2000

Category	Emissions
Energy	3.1 * 10^8 tons of carbon (1.1* 10^6 Gg-CO2)
Industrial processes	0.1 * 10^8 tons of carbon (0.05 * 10^6 Gg-CO2)
Waste	0.1 * 10^8 tons of carbon (0.05 * 10^6 Gg-CO2)
Total	3.3 * 10^8 tons of carbon (1.2 * 10^6 Gg-CO2)

1.2. Projected effects of measures

If we compare totals based on the "Long-Term Energy Supply and Demand Outlook" assuming full compliance with energy-conservation measures with totals assuming no measures had been taken, it is estimated that overall these measures in fiscal 2000 will have an effect equivalent to approximately 30 million tons of carbon (about 120,000 Gg-CO_2). Without these measures, emissions will increase by approximately 10 million tons of carbon in each of the three subcategories under consideration: industry, commercial/residential, and transport.

In industrial process, it is estimated that a reduction in carbon dioxide emissions equivalent to about 2 million tons of carbon (7,000 Gg-CO_2) with respect to the 1990 level is possible by calcining less limestone in cement manufacture and so forth.

As for carbon dioxide emissions from waste, two municipal-waste scenarios were compared. The first assumes that no waste reduction measures are implemented and that the incineration ratio remains at the current level. The second assumes that municipal waste is reduced by 30% and that the incineration ratio continues to increase in line with past trends. Carbon dioxide emissions would be reduced by some 2 million tons of carbon (about 9,000 Gg-CO_2) in the second scenario as compared with the first.

1.3. Projected levels beyond 2000

Total carbon dioxide emissions are expected to stabilize at the 1990 level beyond the year 2000 through implementation of medium- and long-term energy measures. Japan intends to maintain measures in step with world opinion to curb carbon dioxide emissions.

2. Carbon dioxide removals

Projected carbon dioxide removals in fiscal 2000 based on the forest management goals in the Nation-wide

Forest Plan (formulated every five years under the Forest Law) are approximately 25 million tons of carbon (about 92,000 Gg-CO_2), slightly better than in fiscal 1990.

It is necessary to continue to strive for better forest management to achieve the target of the Action Program To Arrest Global Warming: "With respect to sinks of CO_2, efforts should be made to work for the conservation and development of forests, greenery in urban areas and so forth in Japan and also to take steps to conserve and expand forests on a global scale, among others.

3. Methane (CH_4) emissions

3.1. Projection and evaluation of methane emissions in fiscal 2000

It is estimated that total methane emissions will be about 1,150 Gg in fiscal 2000, given the expected effect of energy-conservation measures, measures to reduce municipal waste (Table 3-2) and so forth. This is less than the emissions measured in fiscal 1990 (1,380 Gg); hence the target established in the Action Program To Arrest Global Warming ("The emissions of methane gas should not exceed the present level") is estimated to be achievable.

Table 3-2 Methane Emissions in Fiscal 2000

Category	Emissions
Energy	1.2 * 10^2 Gg
Agriculture	8.9 * 10^2 Gg
Waste	1.4 * 10^2 Gg
Total	11.5 * 10^2 Gg

3.2. Projected effects of measures

It is projected that methane emissions will be reduced by about 10 Gg with respect to 1990 levels by mining less coal.

Methane emissions from agriculture are expected to be about 100 Gg greater in fiscal 2000 than in fiscal 1990, judging from forecasts based on the "Long-Term Prospects for the Demand and Production of Agricultural Products" established in accordance with the "Agricultural Basic Law". It should be noted, however, that surveys are currently being conducted on farming method that will curb the generation of methane, and experimental research is being pursued with regard to fermentation treatment of animal wastes. Because it is difficult at this time to quantitatively project the effects of these efforts, however, they have not been included here.

As for methane emissions from waste, two municipal-waste scenarios were compared. The first assumes that no waste reduction measures are implemented and that the incineration ratio stays at the current level. The second assumes that municipal-waste is reduced by 30% and that the incineration ratio continues to increase in the line with past trends. Methane emissions would be reduced by some 470 Gg in the second scenario as compared with the first.

4. Nitrous oxide (N_2O) emissions

4.1. Projection and evaluation of nitrous oxide emissions in fiscal 2000

Total nitrous oxide emissions are estimated to be about 52 Gg in fiscal 2000, taking into account the effect of measures to save energy and reduce municipal waste (Table 3-3).

This is a slight increase with respect to the 1990 level (48 Gg); further efforts to accelerate development of technology to curb emissions and elucidate the mechanism of nitrous oxide emissions are necessary in order to achieve the Action Program's target, namely: "To the extent possible, the emissions of nitrous oxide and other greenhouse gases should not be increased."

Table 3-3 Nitrous Oxide Emissions in fiscal 2000

Category	Emissions
Energy	25 Gg
Industrial processes	15 Gg
Agriculture	5 Gg
Waste	7 Gg
Total	52 Gg

4.2. Projected effects of measures

It is estimated that energy-conservation measures included in the Long-Term Energy Supply and Demand Outlook, if they are fully implemented, will effectively reduce nitrous oxide emissions in fiscal 2000 by about 2 Gg compared to the level that would be reached if no measures had been taken.

Nitrous oxide emissions from agriculture are estimated to be roughly at the same level in fiscal 2000 as they were in fiscal 1990, based on the forecasts using figures from the "Long-Term Prospects for the Demand and Production of Agricultural Products." The implementation of other measures to curb nitrous oxide emissions is planned, including promotion of the use of slow-release fertilizer, but they have not been taken into consideration here due to the difficulty of quantitatively projecting at the present time the effect these measures will have.

Chapter 1
The Japanese Context

1. The Land and the Forest

1-1. Overview of the Land

Japan is an archipelago located at the far eastern end of the Eurasian continent stretching nearly from 24 degrees to 46 degrees north latitude and consisting of four major islands --- Hokkaido, Honshu, Shikoku, and Kyushu --- as well as more than 6,800 smaller islands. Its total coastline measures 34,000 kilometers. The terrain is mountainous: about 60 percent of Japan is mountainous or hilly. Its plains, of which the Kanto Plain is the largest (about 5,400 square kilometers), are cut off from each other by mountainous or hilly areas; smaller plains average only a few hundred square kilometers each.

Japanese territory as of 1990 extends over 37,770,000 hectares, or about 0.3 percent of the earth's land area; over 80 percent is covered by forest and agricultural land. In recent years, the area left as agricultural land or natural grassland in their natural state has diminished, and the area occupied by building land and roads has increased. A transition has been in progress from agriculture and forestry to progressive urbanization, especially during the period of Japan's most rapid economic growth, which took off in the 1960s.

Table 1-1 Land Use in Japan from 1975 to 1990

Units: 10,000 hectares and percent (figures in parentheses)

Year / Type of Land Use	1975	1980	1985	1990
1. Agricultural Land	576	559	549	534
	(15.3)	(14.8)	(14.5)	(14.1)
Cultivated Land	557	546	538	524
	(14.8)	(14.5)	(14.2)	(13.9)
Grazing Land	19	13	11	10
	(0.5)	(0.3)	(0.3)	(0.3)
2. Forest Land	2,529	2,534	2,529	2,524
	(67.0)	(67.1)	(67.0)	(66.8)
3. Natural Grassland	43	34	30	27
	(1.1)	(0.9)	(0.8)	(0.7)
4. Water Surface	128	131	132	132
	(3.4)	(3.5)	(3.5)	(3.5)
5. Roads	89	99	107	114
	(2.3)	(2.6)	(2.8)	(3.0)
6. Building Land	124	139	151	161
	(3.3)	(3.7)	(4.0)	(4.3)
Residential Land	79	87	94	99
	(2.1)	(2.3)	(2.5)	(2.6)
Factory Land	14	15	15	16
	(0.4)	(0.4)	(0.4)	(0.4)
Other Building Land	31	37	42	46
	(0.8)	(1.0)	(1.1)	(1.2)
7. Other Land	286	281	280	285
	(7.6)	(7.4)	(7.4)	(7.5)
Total	3,775	3,777	3,778	3,777
	(100.0)	(100.0)	(100.0)	(100.0)

Notes:
1. Roads include both general roads and farm and forest roads.
2. Data are estimates based on readily available statistics from different sc
compiled by the National Land Agency.

Source: National Land Agency

Hence Japan's geographical area is limited to start with, and only about 20 percent is being used for residence and agriculture. Its population of over 120 million accounts for 2.5 percent of the world population, but its economy produces 15.6 percent of the world's goods. Per unit geographical area, Japan's economic performance is among the highest in the world.

1-2. Overview of the Forest

Despite its industrial activity, Japan has maintained one of the highest forested land ratios in the industrial world. Japan is more heavily wooded than almost every other major nation. Its forest resources are under maturing stage, with man-made forests at the core of this growth. Japan is building up its timber resources; fully 41 percent of its wooded land has been artificially made. Between 1986 and 1990, Japan's man-made forests grew by 237 million cubic meters to 1,598 million cubic meters of standing trees, exceeding the natural forest total for the first time. Some 70 percent of Japan's natural forest consists of broad-leaved species; between 1986 and 1990, Japan's natural timber resources have grown by 36 million to a total of 1,538 million cubic meters.

2. The Climate

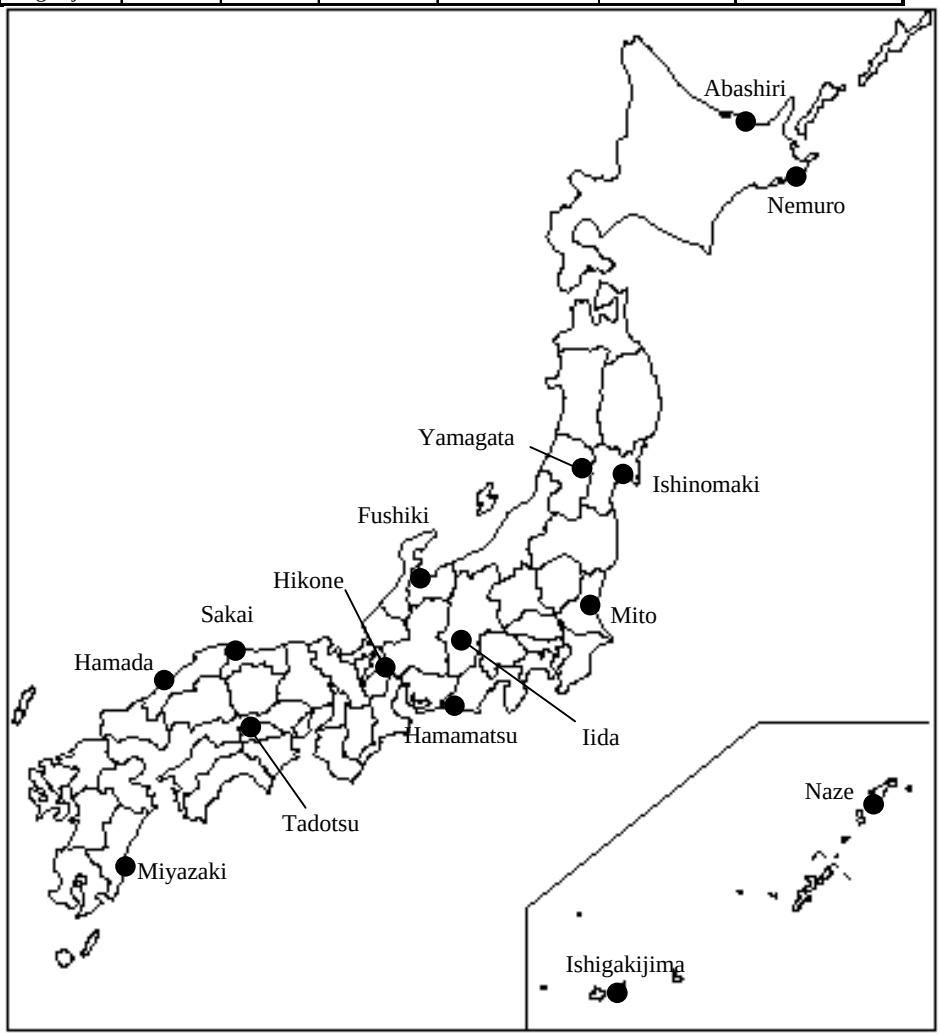
Japan spans a vast range of climatic zones, from subtropical to subarctic. In summer, it is bathed by hot and humid southwesterly winds; in winter, cold monsoon winds invades from the northwest. Compared to the west coast of the continents at the same latitude, there is a greater north-south difference in the climate and seasonal temperature variations are greater, giving Japan four sharply distinct seasons. The mountainous backbone in the middle of Japan's main islands also heightens the climatic differences between different regions of Japan.

The climate (averages for all years from 1961 to 1990) is shown in Table 2-1 based on the representative meteorological data collected at different locations in Japan.

Table 2-1 Meteorological Data at 15 Different Japanese Observatory Sites

		North Latitude	East Longitude	Altitude (meters)	Annual mean Temperature (Celsius)	Maximum Temperature (Celsius)	Minimum Temperature (Celsius)	Annual Precipitation (mm)
Northern Japan	Abashiri	44° 01'	144° 17'	37.6	6.0	9.9	2.4	815.3
	Nemuro	43°20'	145° 35'	25.8	5.9	9.3	2.7	1,035.4
	Yamagata	38°15'	140° 21'	152.5	11.2	16.2	6.8	1,126.3
	Ishinomaki	38° 26'	141° 18'	42.5	11.2	15.2	7.7	1,047.7
Eastern Japan	Fushiki	36° 47'	137° 03'	11.6	13.6	17.6	10.1	2,282.8
	Mito	36° 23'	140° 28'	29.3	13.2	18.4	8.7	1,307.8
	Iida	35° 31'	137° 50'	482.3	12.3	18.4	7.2	1,591.6
	Hamamatsu	34° 42'	137° 43'	31.7	15.7	19.9	12.1	1,884.0
Western Japan	Sakai	35° 33'	133° 14'	2.0	14.6	18.8	10.8	1,984.6
	Hamada	34° 54'	132° 04'	19.0	15.1	18.9	11.3	1,730.6
	Hikone	35° 16'	136° 15'	87.3	14.1	18.4	10.4	1,653.7
	Miyazaki	31° 55'	131° 25'	6.3	17.0	21.9	12.6	2,434.6
	Tadotsu	34° 16'	133° 45'	3.7	15.7	19.7	12.0	1,132.2
Southwestern Islands	Naze	28° 23'	129° 30'	2.8	21.3	24.6	18.3	2,870.7
	Ishigakijima	24° 20'	124° 10'	5.7	23.8	26.5	21.6	2,065.8

		North Latitude	East Longitude	Altitude (meters)	Annual Sunshine Duration (hours)	Heat Requirements (°C-days)	Air Conditioning Requirements (°C-days)
Northern Japan	Abashiri	44° 01'	144° 17'	37.6	1845.0	3,076	
	Nemuro	43° 20'	145° 35'	25.8	1856.8	2,957	-
	Yamagata	38° 15'	140° 21'	152.5	1667.0	1,907	30
	Ishinomaki	38° 26'	141° 18'	42.5	1995.0	1,735	-
Eastern Japan	Fushiki	36° 47'	137° 03'	11.6	1604.7	1,320	105
	Mito	36° 23'	140° 28'	29.3	1830.3	1,306	38
	Iida	35° 31'	137° 50'	482.3	1935.1	1,605	19
	Hamamatsu	34° 42'	137° 43'	31.7	2132.8	823	127
Western Japan	Sakai	35° 33'	133° 14'	2.0	1769.7	1,059	134
	Hamada	34° 54'	132° 04'	19.0	1754.3	862	114
	Hikone	35° 16'	136° 15'	87.3	1824.8	1,221	125
	Miyazaki	31° 55'	131° 25'	6.3	2102.9	567	210
	Tadotsu	34° 16'	133° 45'	3.7	2074.0	864	195
Southwestern Islands	Naze	28° 23'	129° 30'	2.8	1435.9	-	394
	Ishigakijima	24° 20'	124° 10'	5.7	1845.2	-	623



Location of the 15 Japanese observatory sites whose meteorological data are shown in the above table.

Over the past 90 years, annual mean temperatures were generally low through the mid-1940s, from which time they began to rise, tending to be high for a few years before and after 1960; there followed a relatively cold period, then a new rise beginning in the latter half of the 1980s. Over the long term, the rate of

temperature increase has been 0.9 degrees Celsius per 100 years.

The tendency observed since the late 1980s for average temperatures to rise is especially marked geographically in northern Japan and seasonally in the winter.

3. The Population

Japan's population rose abruptly immediately after World War II, due to repatriation of overseas Japanese and the postwar baby boom. The birthrate then plummeted immediately thereafter, falling by the mid 1950s to an annual rate of population growth of less than 2 percent. During the 1970s, Okinawa's retrocession and the second baby boom again momentarily boosted the demographic growth rate, but this later subsided. At the end of the 1980s, population growth sank to 0.4 percent annually. As of October 1, 1990, Japan's population was 123,611 thousand.

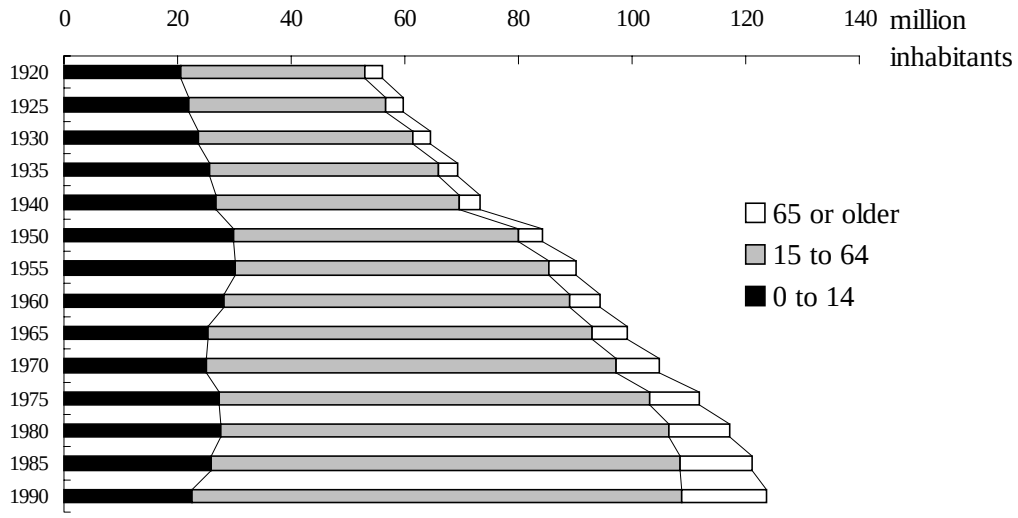
Table 3-1 Japan's Population, Population Growth, and Population Density from 1970 to 1990

Census date	Population	Increase with Respect to Previous Census		Population Density per Square Kilometer
		Additional Population Since Last Census	Percent Increase	
Oct. 1, 1970	104,665,171	5,456,034	5.5	281
Oct. 1, 1975	111,939,643	7,274,472	7.0	300
Oct. 1, 1980	117,060,396	5,120,753	4.6	314
Oct. 1, 1985	121,048,923	3,988,527	3.4	325
Oct. 1, 1990	123,611,167	2,562,244	2.1	332

Population Census(M.C.A)

As the postwar birthrate began to fall, the average age of the Japanese population began to rise. Children (age 0 to 14) have continued to become an ever smaller percentage of the total population, year after year, sinking to 18.2 percent (22,486 thousand) in 1990; the population of productive age (15 to 64) has continued to increase, rising to 69.5 percent (85,904 thousand) in 1990; the elderly population (65 or older) is also a continuously growing segment, now 12.0 percent (14,895 thousand) of the total population in 1990.

Figure 3-1 Age Distribution of the Japanese Population from 1920 to 1990



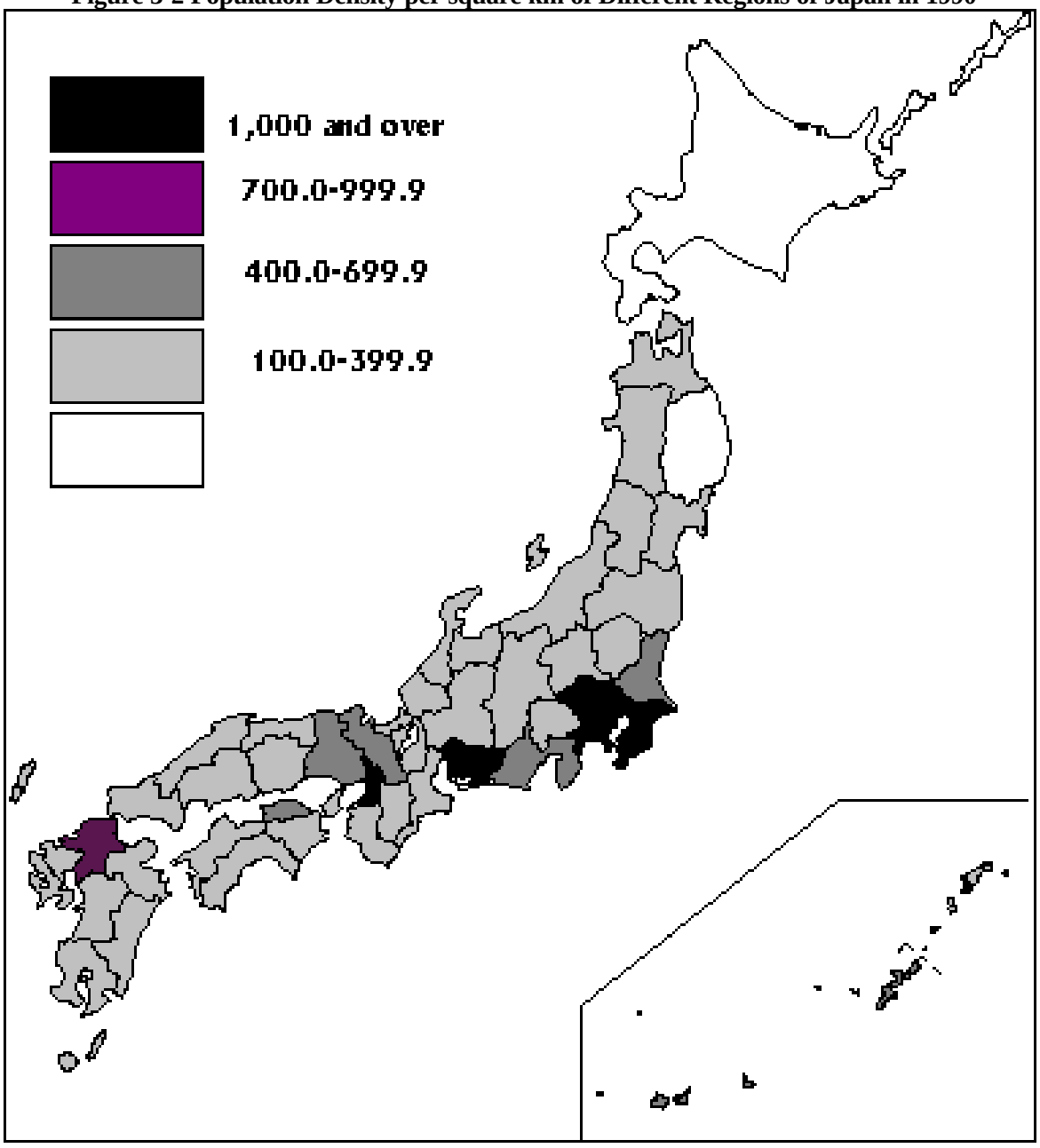
Population Census (M.C.A.)

During the Japanese economic miracle years of the 1960s, when the economy was growing very rapidly, major internal migrations swelled the population of Japan's three metropolitan areas: Tokyo, Osaka, and Nagoya. Net immigration into the three metropolitan areas decreased in the 1970s, but the transition to a services-oriented economy, computerization, and the internationalization of the Japanese economy beginning in the 1980s continued to accentuate the densification of the Tokyo metropolitan area's population; this trend peaked in 1987 and has been weakening since then. In sum, the great migratory afflux of population into the Tokyo metropolitan area has been clearly slowing for the last few years.

In 1990, Japan's three metropolitan areas accounted for 43.6 percent of the entire population. Compared to the national population density of 332 inhabitants per square kilometer, the Tokyo metropolitan area's was 3,831, the Osaka metropolitan area's 2,183, and the Nagoya metropolitan area's 1,150 inhabitants per square kilometer.

The amount of CO emissions per capita in fiscal 1990 was 9.49 tons (2.59 carbon tons/person).

Figure 3-2 Population Density per square km of Different Regions of Japan in 1990



4. Households and Houses

In 1990, there were 40,670,000 ordinary households in Japan, 7.1 percent more than in 1985. Household size is shrinking: the average number of related people living together under one roof has fallen from 3.37 in 1970 to 2.98 in 1990, less than 3 for the first time.

Housing survey from 1988 indicate the existence of 42,010 thousand dwellings, more than enough quantitatively to house the total of 37,810 thousand households nationwide. Qualitatively, average area of floor space per dwelling is 89.29 square meters; though this is an increase with respect to previous decades, it is not yet regarded as sufficient.

Table 4-2 Area of Floor Space per Dwelling (in Square Meters)

	Average, Both Types of Dwelling	Own Dwelling	Rented Dwelling
1968	73.86	97.42	38.05
1973	77.14	103.09	39.49
1978	80.28	106.16	40.64
1983	85.92	111.67	42.88
1988	89.29	116.78	44.27

Source: Report on Housing Statistics Survey, Management and Coordination Agency.

5. Japan's Industry and Economy

Japan's economy grew extremely rapidly in the 1960s thanks to the development of heavy industry, producing mainly such key materials as steel and chemicals, and to the expansion of exports. (Real economic growth during the 1960s averaged 10.3 percent per annum.) In the process, the center of gravity in Japan's industrial structure shifted from the primary to the secondary sector. Japanese heavy industry became a voracious resource and energy consumer. In agriculture, as the workforce and other resources were transferred out of farming into other activities, agricultural production was nonetheless able to grow thanks to its selection and offering of new products and development of new technology. In forestry, fossil fuels and other fuels increasingly replaced natural forest fuels and increased wood's importance as a building material.

First in 1973, then again in 1979, successive oil crises struck Japan. In 1974, Japan's economy recorded the first negative growth since the war, and for some time thereafter economic growth remained slow. The economic growth rate began to decline in 1973; the real economic growth rate for the 1970s averaged 4.5 percent per year. Manufacturing in particular began efforts to increase the efficiency of energy use, making major new energy-saving investments; in electric appliances, machines, and other processing and assembly industries, relatively uninfluenced by rising energy costs, emphasis was placed on labor saving and increasing value-added by introducing new technologies; as shifts in the industrial structure continued, the tertiary sector acquired increasing importance. In agriculture, most of Japan's needs were being met: it began to produce more than it consumed, with the exception of meat and dairy products and fats and fatty oils.

In the autumn of 1985, the yen began to become much stronger on exchange markets, severely hurting Japanese industry, which in general was very dependent on exports. Japan responded by restructuring its consumer market, boosting personal spending and other internal demand, and accommodating diversifying and ever more sophisticated consumer needs in a context where workers had more leisure time and higher income levels. Services and the tertiary sector acquired ever more weight within the economic system, employing a growing proportion of the workforce, 51.0 percent in 1970, 60.7 percent in 1990. The growth of the economy's services and software components, augmented by growing service-and-software-providing sectors even within primary and secondary industry, together with advances in microelectronics, promoted an on-going transition to

an internal-demand-oriented economy.

From 1987 to mid-1990, driven by internal demand, the rapidly growing Japanese economy (from 1987 to 1990, the economic growth rate was 5.4 percent per year), continued to forge ahead under its own steam; major growth in corporate profits and in demand for office space in downtown Tokyo, falling interest rates, and other economic conditions stimulated expectations that prices would rise, triggering skyrocketing real estate prices. When land prices were perceived to have outpaced improvement in the economy's fundamentals, they plummeted, bursting the bubble and putting an end to the boom. From the second half of 1991 the economy entered a long adjustment phase. For the first time since the first oil crisis, mining and manufacturing production fell to well below the previous year's level.

Agricultural production generally stagnated or regressed in a basically glutted market. Gaps between domestic and overseas prices widened as the yen became stronger; imports of meat, tea, coffee, alcoholic beverages, semi-processed foods, and similar products grew, posing a stronger competitive threat to domestic farm produce. In forestry, secondary and tertiary industry continued to grow and the rural population continued its exodus; this exodus and population aging continued to undermine the forestry sector, where domestic lumber found itself increasingly exposed to fierce competition, both from imports and from lumber substitutes.

The amount of CO_2 emissions per GDP in fiscal 1990 was 380 tons/million dollars (103.6 carbon-tons/million dollars.)

Table 5-1 Gross Domestic Product and Nominal Gross Domestic Expenditure from Fiscal 1970 to Fiscal 1991 (Unit: Billion Yen)

Item	1970	1975	1980	1985	1986	1987	1988	1989	1990	1991
Compensation of Employees	33,243.4	83,765.0	132,838.6	176,215.6	183,290.3	191,098.6	202,598.5	218,559.5	236,951.5	254,734.0
Operating Surplus	27,932.9	40,377.9	66,938.2	82,162.7	84,771.8	88,364.3	94,649.4	98,166.5	103,147.9	100,958.7
Fixed Capital Consumption	10,108.1	19,261.3	31,829.9	44,376.3	46,890.0	49,642.1	53,327.0	59,891.3	63,900.8	69,815.3
Indirect Taxes	5,385.0	9,846.3	18,110.5	24,380.6	26,055.8	28,726.2	31,639.4	33,163.2	35,044.6	36,998.9
Less: Subsidies	881.3	2,110.5	3,654.0	3,697.1	3,470.4	3,480.9	3,392.5	4,779.4	3,400.8	3,286.9
Statistical Discrepancy	-489.6	1,221.6	-516.6	720.9	815.2	-361.3	-1,933.2	-2,689.8	-3,055.5	-3,358.6
Gross Domestic Product	75,298.5	152,361.6	245,546.6	324,159.0	338,352.7	353,989.1	376,888.6	402,311.3	432,588.5	455,861.5
Private Final Consumer Expenditure	39,456.6	86,994.6	143,613.3	190,575.4	198,091.5	206,799.7	218,232.8	231,853.9	246,446.2	258,189.8
Government Final Consumer Expenditure	5,646.9	15,261.5	24,122.4	31,038.0	32,559.9	33,241.0	34,564.8	36,733.6	39,520.1	41,670.6
Gross Domestic Fixed Capital Formation	26,683.7	49,447.2	77,096.9	89,208.9	92,337.8	102,817.9	113,684.6	125,857.2	140,104.9	143,301.8
Increase in Stocks	2,436.7	361.0	1,775.4	2,076.3	1,266.6	1,184.8	2,265.3	3,146.9	2,697.2	3,331.3
Exports of Goods and Services	8,287.3	19,551.1	33,569.4	44,497.5	37,394.0	36,070.0	38,708.9	43,714.2	46,210.1	47,107.0
Less: Imports of Goods and Services	7,212.6	19,253.9	34,630.8	33,237.1	23,297.1	26,124.4	30,567.7	38,994.5	42,389.9	37,739.1
Gross Domestic Expenditure	75,298.5	152,361.6	245,546.6	324,159.0	338,352.7	353,989.1	376,888.6	402,311.3	432,588.5	455,861.5
Reference										
Factor Incomes from the Rest of the World	369.8	1,236.5	2,877.5	5,648.9	5,687.1	8,296.9	10,979.3	16,603.0	18,764.9	19,705.2
Less: Factor Incomes to the Rest of the Worl	516.3	1,388.6	3,064.2	4,437.3	4,354.5	6,022.3	8,637.9	13,110.5	15,991.7	16,547.9
Gross National Product	75,152.0	152,209.4	245,360.0	325,370.5	339,685.3	356,263.6	379,230.0	405,803.9	435,361.6	459,018.7

Source:Report on National Accounts, Economic Planning Agency.

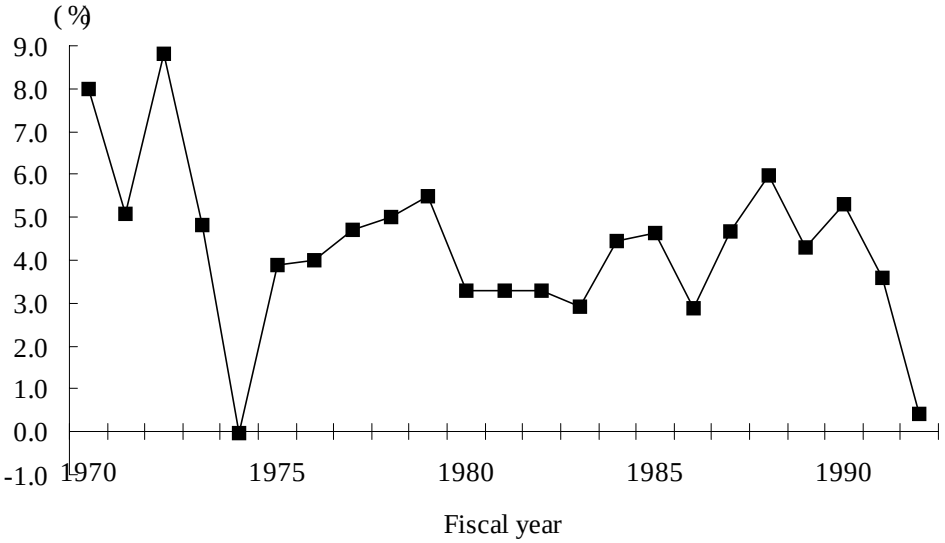
Table 5-2 Gross Domestic Expenditure from Fiscal 1970 to Fiscal 1991 (Unit: Billion Yen)

Item	1970	1975	1980	1985	1986	1987	1988	1989	1990	1991
Private Final Consumer Expenditure	102,656.2	133,711.9	162,320.5	190,140.9	197,354.6	205,472.1	216,811.1	224,852.4	232,965.5	239,016.5
Government Final Consumer Expenditure	16,845.0	21,930.3	26,916.9	30,786.1	32,178.2	32,320.5	33,030.0	33,617.6	34,443.0	34,765.8
Gross Domestic Fixed Capital Formation	57,228.9	66,491.7	79,528.8	89,229.6	93,703.7	104,811.3	115,881.9	126,012.2	137,176.0	139,358.9
Increase in Stocks	4,279.2	744.0	1,628.7	1,910.0	1,326.9	1,300.1	2,987.3	3,554.6	2,946.1	3,977.9
Exports of Goods and Services	13,626.5	20,948.1	32,954.1	46,032.5	44,167.6	44,701.9	48,611.0	52,622.6	56,170.8	59,083.2
Less: Imports of Goods and Services	21,269.1	27,976.9	34,324.9	35,346.1	36,727.5	41,070.7	48,970.8	56,518.0	59,140.5	57,167.4
Gross Domestic Expenditure	173,366.8	215,849.0	269,024.2	322,752.9	332,003.6	347,535.2	368,350.6	384,141.3	404,561.0	419,034.9

Source: Report on National Accounts, Economic Planning Agency.

Figure 5-1 Gross Domestic Product (Percent Changes from Previous Fiscal Year)

(At Market Prices in Calendar Year of 1985)



Source: Report on National Accounts, Economic Planning Agency

Table 5-3 Per Capita Gross Domestic Product from Fiscal 1970 to Fiscal 1991
(At Market Prices in Calendar Year of 1985)

	1970	1975	1980	1985	1986	1987	1988	1989	1990	1991
Per Capita Real Gross Domestic Product (yen)	1,674,687	1,945,482	2,315,284	2,689,432	2,750,183	2,863,393	3,022,383	3,140,069	3,295,948	3,402,454

Source: Report on National Accounts, Economic Planning Agency; National Population, Household Statistics;
Population Dynamics, Ministry of Home Affairs.

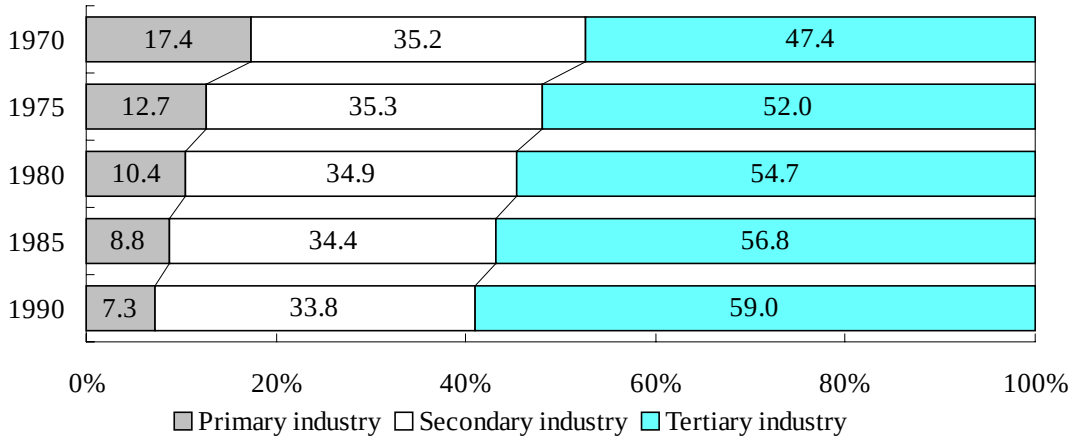
Table 5-4 Gross Domestic Product by Kind of Economic Activity from 1970 to 1991
(At Market Prices in Calendar Year of 1985)

(billion yen)

Kinds of economic activity	1970	1975	1980	1985	1986	1987	1988	1989	1990	1991
1. Industry	152938.9	193647.0	245551.8	301175.2	305787.2	323129.0	345287.4	366610.7	387807.1	402020.4
(1) Agriculture, Forestry, Fisheries	6596.9	10767.3	9134.9	10213.7	10006.1	10325.1	9994.6	10328.3	10381.2	9595.1
(2) Mining	1065.8	970.8	1181.6	958.5	995.7	937.5	959.8	890.3	1116.7	1096.7
(3) Manufacturing	43056.6	52419.2	71481.8	94672.6	92112.6	98860.2	107999.4	116619.4	125492.4	133420.8
(4) Construction	19968.1	24733.1	26325.8	25381.3	26296.6	29124.1	32071.0	33622.8	35640.7	36500.3
(5) Electricity, Gas, and Water Supply	5314.9	6618.9	8181.3	10305.4	10437.4	10683.8	11430.5	11952.8	12731.0	13639.9
(6) Wholesaling and Retail Trade	16744.8	24677.4	38068.9	42835.8	44251.1	46963.3	49684.7	51483.9	55255.5	57254.8
(7) Finance and Insurance	4845.9	8454.5	11921.2	16971.9	18800.3	20949.9	22963.6	25472.8	24905.3	24727.0
(8) Real Estate	14955.2	21000.7	27571.9	32358.5	33711.2	35355.8	37198.7	38865.3	40016.5	40693.1
(9) Transportation and Communication	13691.4	16813.3	16998.7	21086.7	21368.4	21936.8	23274.1	24637.2	25354.9	26256.3
(10) Services	23699.3	27191.7	34685.6	46390.9	47807.8	47992.3	49711.1	52737.8	56912.9	58836.5
2. Producers of Government Services	15912.2	19416.4	23486.8	26284.5	26502.7	26779.0	26999.7	27162.9	27261.6	26948.2
(1) Electricity, Gas, and Water Supply	366.6	579.1	766.3	970.1	1016.9	1088.0	1110.3	1152.2	1192.1	1214.7
(2) Services	6890.3	8181.5	9747.4	10919.2	11045.8	11158.2	11236.8	11263.2	11247.2	11162.8
(3) Public Administration	8555.2	10655.8	12973.1	14395.2	14440.1	14532.8	14652.7	14747.5	14822.4	14570.7
3. Producers of Private Non-profit Services to Households	2947.1	3956.4	5064.8	6218.4	6439.5	6625.9	6917.4	7127.6	7212.8	7398.2
(1) Services	2947.1	3956.4	5064.8	6218.4	6439.5	6625.9	6917.4	7127.6	7212.8	7398.2
Subtotal	171698.1	217019.7	274103.4	333678.1	338729.4	356533.8	379204.6	400901.1	422281.5	436366.7
Import Duty	1950.0	800.5	1273.9	1353.2	1583.0	1830.2	2043.7	2706.6	2504.7	3213.1
Less: Miscellaneous										
Less: Imputed Bank Service Charges	4921.6	8202.6	10413.6	14773.5	14832.9	17105.2	18126.5	21947.7	23538.6	23794.4
Gross Domestic Product (Excluding Statistical Discrepancies)	168726.5	209617.7	264963.7	320257.8	325479.5	341258.8	363121.8	381660.0	401247.6	415785.4
Statistical Discrepancies	2934.9	3490.1	1758.4	139.4	3336.7	1056.4	445.3	950.7	-2204.6	252.9
Gross Domestic Product	171661.4	213107.8	266722.1	320397.2	328816.3	342315.2	363567.1	380709.4	399043.1	416038.3

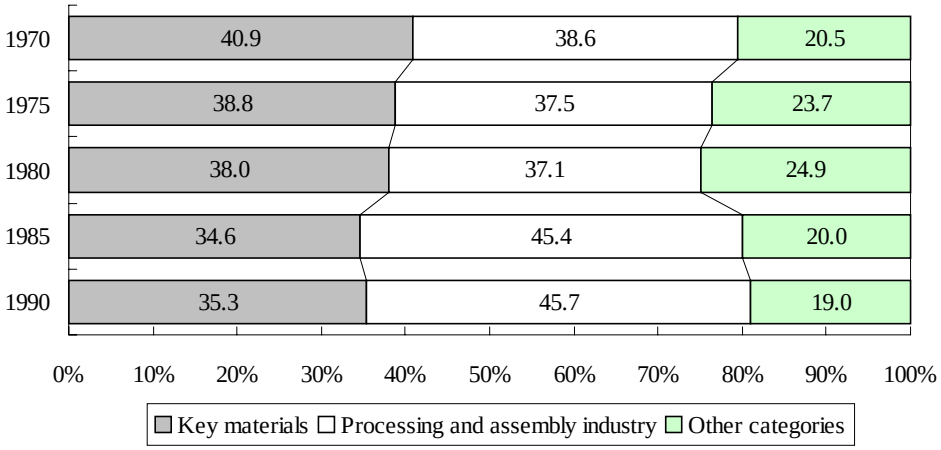
Source: Report on National Accounts, Economic Planning Agency.

Figure 5-2 Jobs, by Sector



Source: Population Census (M.C.A)

Figure 5-3 Manufacturing Industry Composition: Percent Value-added Generated by Different Types of Manufacturer



Source: Industrial Census, MITI.

6. Transport

Domestic passenger transport grew very significantly throughout the period of rapid economic growth thanks to economic expansion, rising income levels, upgrading of industrial structure, increasing leisure, and the ensuing growing demand for higher speed, more comfort, and greater mobility; transport system improvement and network expansion helped to shorten transport times and motorization made great inroads. During the 1960s, the number of domestic passengers doubled and the distances they traveled increased 2.4 fold. With more passenger cars available and income levels rising, private automobile ownership began to grow from about 1960, topping the 10 million mark in 1967 and reaching 5.6 times the 1960 number in 1970 at 18.92 million. Thus between 1960 and 1970, the distribution of traffic shifted between different means of transportation, and although the railroad significantly increased its traffic in absolute terms with the opening of the first Shinkansen "bullet train" line in 1964, on the whole its share fell from 75.8 percent to 49.2 percent and motor vehicles' share rose from

22.8 percent to 48.4 percent of passenger-kilometers traveled in the decade of the 1960s. Air traffic is a tiny fraction of the whole, but its time-saving features and the introduction of jets for domestic flights in 1961 gave airlines faster and bigger aircraft that increased their traffic 12.6 fold in a decade.

After the first oil crisis (i.e., after 1973), growth in domestic passenger traffic began to taper off; in fiscal 1976, the number of passenger-kilometers actually dwindled. By the end of the 1970s, however, the rising national standard of living and more free time to enjoy it helped to fuel continuing growth in car ownership, especially people's family cars: in 1971, the number topped 20 million, in 1976, it rose above 30 million. Throughout the 1970s, domestic passenger transport increased almost parallel to the passenger transport traveled by privately owned automobiles and the number of passenger-kilometers traveled in motor vehicles in proportion to transport volume by all means of transport combined outdid the railroad for the first time in 1971, topping 50 percent. During the 1970s, motor vehicle passenger transport grew 1.4 fold in terms of the number of passengers carried and 1.5 fold in terms of the number of passenger-kilometers traveled. Air transport saw the introduction of jumbo jets in 1970 and relatively cheaper airfares as well as a growing preference for faster means of transportation; thus by the end of the 1970s the volume of traffic had increased 3.2 fold and air's share of total traffic had grown from 1.6 percent in 1970 to 3.8 percent in 1980. During this decade, rail saw its share shrink, as did bus transport, whose service suffered from the difficulty of keeping on schedule during inner city rush hours and the consequent lowering of bus speeds, the continuing exodus from rural areas, and the rapid advance of motorization. As a result, by the end of the 1970s, rail transport's share was only about one-half what it had been twenty years earlier.

From 1980 on, domestic passenger transport volume increased at an annual rate of 2.3 percent; in the twenty-five year period ending in 1990, the number of passengers increased 2.1 fold, the number of kilometers traveled 2.9 fold.

Domestic cargo volume followed the GNP's upward path during Japan's rapid economic growth phase; throughout the 1960s, tonnage increased 3.4 fold and distances carried (ton-kilometers) 2.5 fold. Cargo transport by motor vehicle showed especially rapid growth, due to the development of heavy trucks and similar transport equipment; tonnage increased 4 fold, ton-kilometers 6.5 fold. Coastal shipping saw development of special ships for different types of cargo and growth in the volume of industrial cargo, principally raw materials for the petrochemical, steel, cement, and other key heavy industries. Rail transport's business barely increased at all, however, due to very sluggish growth in the volume of primary commodities, the main type of cargo transported by rail.

Under the impact of the first oil crisis, domestic cargo volume diminished sharply in 1974 and 1975; when the second oil crisis struck, internal demand and shipments by materials industries again stagnated and cargo volumes shrank as oil consumption decreased with conversion to other forms of energy. From the 1980s, industrial restructuring triggered by the oil crises and the shift to a services-oriented economy and a weakening of industrial activity's transport-demand-inducing effect led to slow or no growth at all in cargo volume, while GNP rose, now unharnessed from cargo volume. More recently, cargo volume has shown signs of increasing under the effect of the major, domestic-demand-led economic expansion. Trucks and other road vehicles now account for a growing share of the transport market, thanks to the increasing frequency of smaller deliveries; in 1986, trucking

outdid coastal shipping, and in 1987, it topped the 50 percent mark. As a consequence of smokestack industries' decline, growth in coastal shipping has remained rather slack, but with the recent economic expansion it has shown some growth; in 1988, coastal shippers exceeded their second-oil-crisis cargo level. Thanks to the growing preference for speedy transport and the increasing value of time as a transport factor and the relative decline in the importance of freight charges/fares due to rising income levels, air freight is now used to ship machine parts, fresh foods, books, and similar goods, and although its share of the total is small, about 11 times as much cargo was shipped by air in 1990 than twenty years before. Rail has seen its share steadily decline, to below 10 percent in 1979, but with the recent economic pickup and growth of container and other forms of transport, volume is growing, checking the slide in rail's share.

Table 6-1 Domestic Passenger Traffic (in Passenger-kilometers)

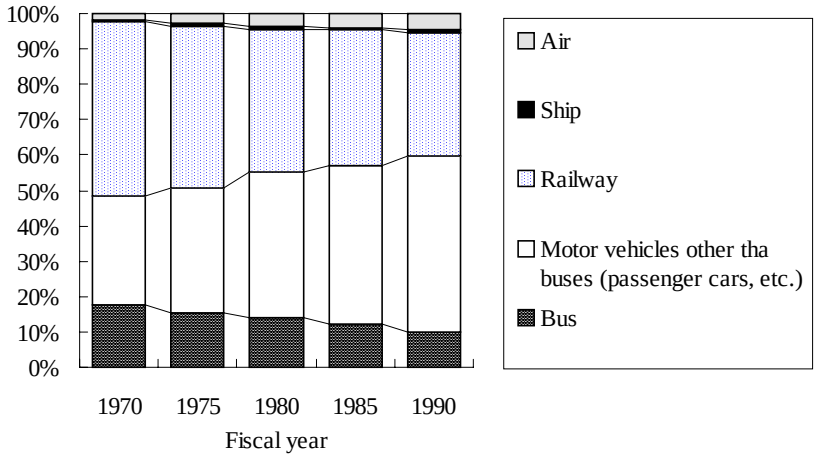
Fiscal Year	Million Passenger-kilometers Traveled						
	Total	Motor Vehicles	Buses	Other Motor Vehicles (passenger cars, etc.)	Railway	Ship	Air
1970	587,176	284,228	102,893	181,335	288,815	4,814	9,319
1975	710,710	360,867	110,063	250,804	323,800	6,895	19,148
1980	782,030	431,668	110,396	321,272	314,542	6,132	29,688
1985	858,232	489,260	104,898	384,362	330,101	5,752	33,119
1986	875,593	499,844	101,628	398,216	334,741	5,684	35,324
1987	1,107,984 (930,238)	718,478 (540,732)	102,895	615,583	344,729	6,242	38,535
1988	1,190,641 (998)	782,032 (589,178)	107,221	674,811	361,796	5,711	41,102
1989	1,267,044 (1,066,324)	845,123 (644,403)	109,130	735,993	368,818	5,962	47,141
1990	1,298,437 (1,108,160)	853,061 (662,784)	110,372	742,689	387,478	6,275	51,623
1991	1,330,965 (1,134,699)	869,338 (673,072)	108,212	761,126	400,083	6,195	55,349

Note: Figures are not continuous: since 1987, cars with small displacements and trucks used as family cars have been included in "Other motor vehicles." Therefore, in the total and after 1986 in the figure for "Motor vehicles," the total excluding these subcompact cars and trucks used as family cars is placed in parentheses

Source: Statistical Trends in Land Transport (1992 edition) Japan Automobile Chamber of Commerce.

Figure 6-1 Shares of Different Means of Transportation Carrying Domestic Passenger Traffic

(in Passenger- kilometers)



Note: “Motor vehicles other than buses (passenger cars, etc.)” does not include subcompact cars and trucks used as family cars.

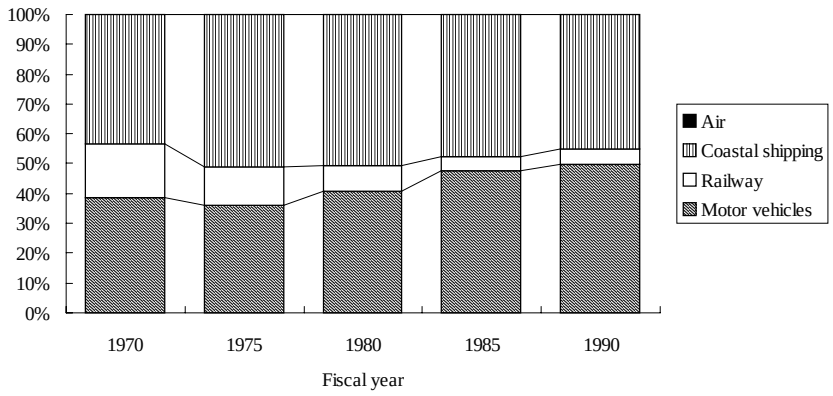
Sources: Statistical Trends in Land Transport (1992 edition), Japan Automobile Chamber of Commerce

Table 6-2 Motor Vehicle Ownership

Fiscal year	Number of motor vehicles owned	Trucks	Buses	Passenger Cars	Special-purpose Vehicles	Small Motorcycles	Subcompact Cars
1970	18,919,020	5,460,393	190,066	6,776,949	351,661	171,533	5,968,418
1975	29,143,445	7,381,024	219,945	14,822,093	595,798	257,208	5,867,377
1980	38,992,023	8,682,978	229,429	21,543,500	794,025	444,975	7,297,116
1985	48,240,555	8,306,018	230,783	25,847,578	943,801	850,615	12,061,760
1986	50,223,439	8,271,278	232,011	26,687,691	987,559	911,897	13,133,003
1987	52,645,676	8,351,946	234,648	27,824,733	1,037,272	974,218	14,222,859
1988	55,136,643	8,549,446	239,053	28,975,539	1,097,223	1,016,070	15,259,312
1989	57,993,866	8,695,110	242,295	30,881,580	1,154,624	1,045,519	15,974,738
1990	60,498,850	8,834,541	245,844	32,436,497	1,213,569	999,854	16,768,545
1991	62,713,454	8,920,738	247,968	33,950,579	1,271,636	1,022,602	17,299,931

Source: Statistical Trends in Land Transport (1992 edition) Japan Automobile Chamber of Commerce.

Figure 6-2 Shares of Different Means of Transport Carrying Domestic Cargo (in Ton-kilometers)



Note: “Motor vehicles” do not include subcompacts.

Sources: Statistical Trends in Land Transport (1992 edition), Japan Automobile Chamber of Commerce

Table 6-3 Domestic Cargo Volume (in Ton-kilometers)

Fiscal Year	Million Ton-kilometers carried				
	Total	Motor Vehicles	Railway	Coastal Shipping	Air
1970	350,264	135,916	63,031	151,243	74
1975	360,490	129,701	47,058	183,579	152
1980	438,792	178,901	37,428	222,173	290
1985	434,160	205,941	21,919	205,818	482
1986	435,059	216,115	20,446	197,953	545
1987	448,919 (446,547)	226,425 (224,053)	20,474	201,386	634
1988	482,877 (480,663)	246,088 (243,874)	23,478	212,628	683
1989	508,809 (506,672)	262,857 (260,720)	25,136	220,063	753
1990	546,785 (544,698)	274,244 (272,157)	27,196	244,546	799
1991	559,948 (557,758)	283,776 (281,586)	27,157	248,203	812

Note: Figures are not continuous: since 1987, cars with small displacements and trucks used as family cars have been included in "Motor Vehicles." Therefore, in the total and after 1986 in the figure for "Motor vehicles," the total excluding subcompact cars and trucks used as family cars is placed in parentheses.

Source: Statistical Trends in Land Transport (1992 edition), Japan Automobile Chamber of Commerce.

7. Energy

7-1. Consumption

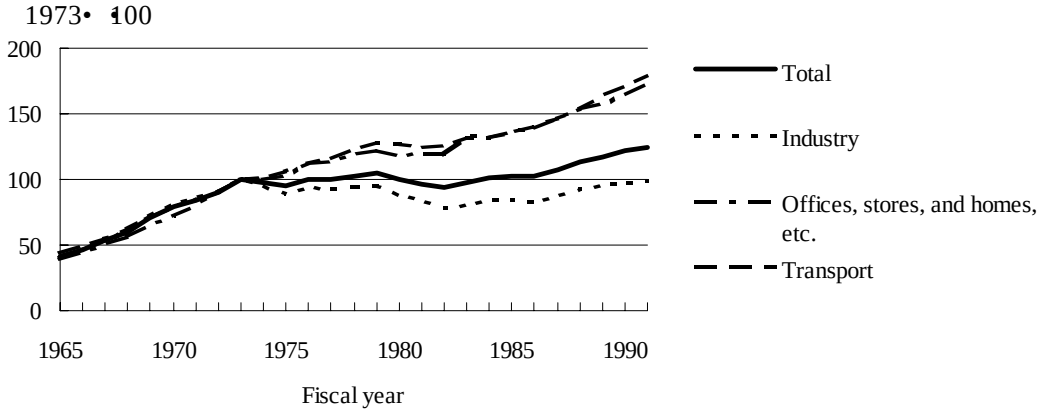
End-user energy consumption continued to increase significantly with the Japanese economy's rapid growth during the 1960s and until the first oil crisis in 1973, after which it leveled off and eventually decreased. From 1986 on, however, the economic pickup primed new growth in energy consumption, to the equivalent of 349 million kiloliters of oil (322,969 10^{10} kcal, gross calorific value, as below) in fiscal 1990.

These trends can be summarized for different sectors as follows: until the first oil crisis in 1973 (phase I), industrial, residential and commercial, and transport sector energy consumption grew rapidly. From fiscal 1973 until 1986 (phase II), residential and commercial and transport sector energy consumption continued to grow on the whole, but industrial energy consumption began to decrease, thanks to Japanese industry's development of world-class energy saving technology and shift to an energy-economizing industrial structure. After 1986 (phase III), the strong economy boosted energy consumption in all three sectors --- industrial, residential and commercial, and transport --- and the growth was especially great in energy consumption by the residential and commercial and transport sectors.

Through these trends, the different sectors' shares of total end-user energy use underwent changes: though industry's share remained very large, it decreased; the residential and commercial and transport sectors' shares grew. In fiscal 1990, the industrial sector's share of total energy

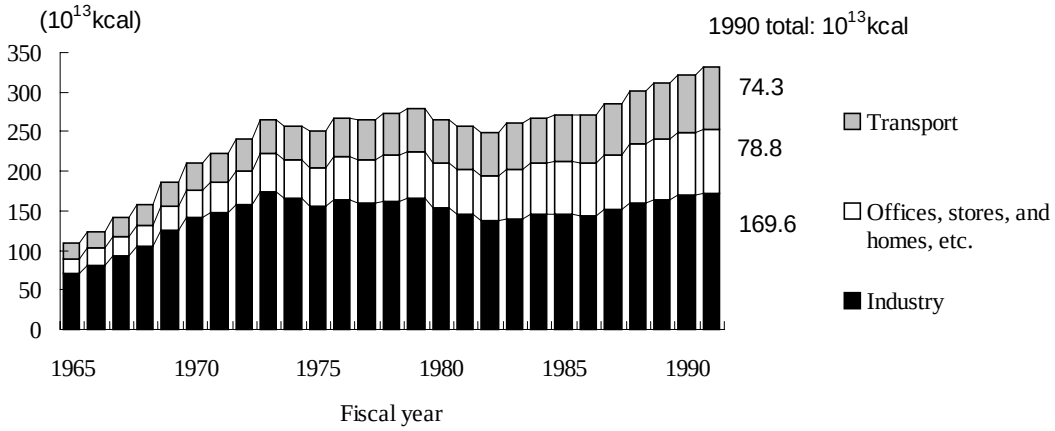
consumption was 53 percent (including uses of oil, etc., for other than energy uses); the residential and commercial sector's was 24 percent, and transport's was 23 percent.

Figure 7-1 Final Consumer Energy Consumption



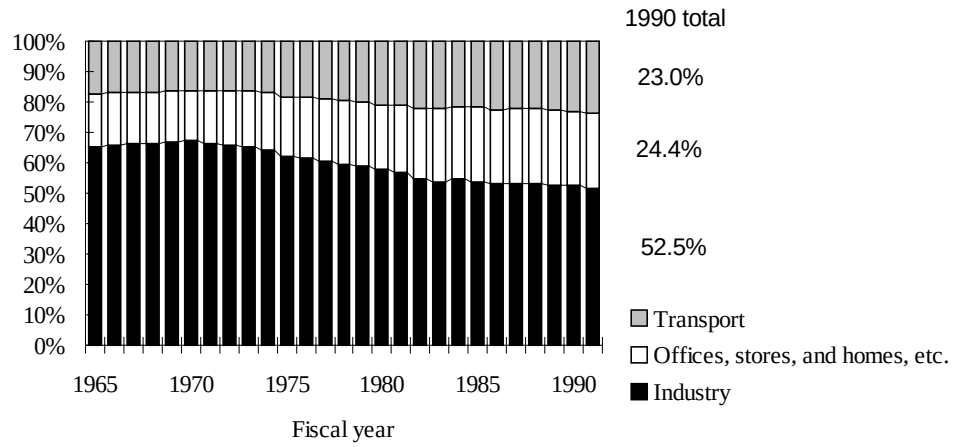
Source: Comprehensive Energy Statistics, MITI.

Figure 7-2 Final Consumer Energy Consumption



Source: Comprehensive Energy Statistics, MITI.

Figure 7-3 Final Consumer Energy Consumption: Change in Different Sectors' Shares



Source: Comprehensive Energy Statistics, MITI.

Energy consumption trends differ according to the form of energy in question. Electricity and gas consumption have been growing uninterruptedly: in 1990, they were respectively 1.8 times and 2.1 times their fiscal 1973 level. Coal consumption has been increasing, albeit very gradually. Oil consumption grew rapidly during phase I, leveled off during phase II, and has begun to grow again since Japan entered phase III.

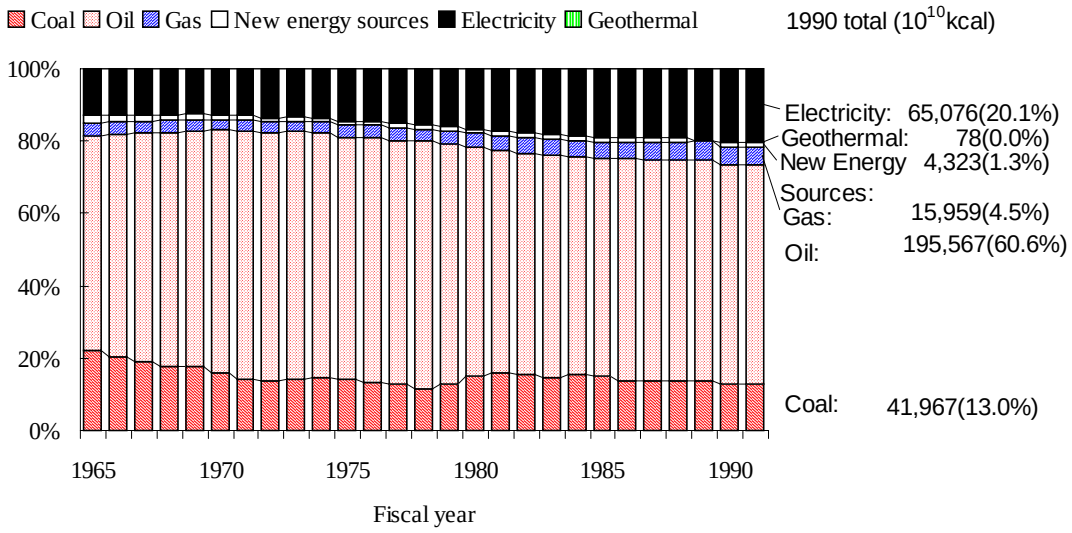
Different energy sources' respective shares of end-user consumption also differ. During phase I, coal's share decreased, as coal was replaced by oil, whose share increased. During phase II, coal's share remained almost constant, while oil's began to shrink and electricity's and gas's shares increased.

Recent growth in demand has been higher for electricity than for other forms of energy consumed by end-users; as a result, the proportion of energy consumed to make electricity has risen from 27 percent of the total primary energy supply in fiscal 1973 to 39 percent in fiscal 1990.

7-2. Supplies

Japan has almost no indigenous energy resources of its own: its dependence on foreign sources peaked in fiscal 1973 at 89.4 percent of its energy supply; since then, this dependence has been reduced by efforts to find substitutes for oil; in recent years, foreign dependence has remained slightly above 80 percent. Japan is dependent on foreign sources for more than 99 percent of its oil, however, leaving Japan still in an extremely vulnerable energy supply situation.

Figure 7-4 Final Energy Consumption by Energy Source



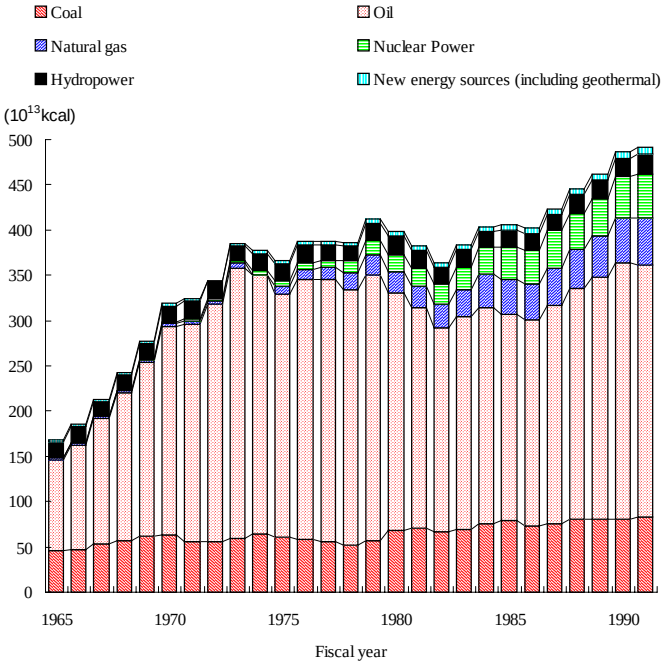
Note: “Oil” refers to both crude oil and petroleum products; “coal” refers to both coal and coke; “gas” refers to natural gas, liquefied petroleum gas, and town gas.

Source: Comprehensive Energy Statistics, MITI.

Japan's total primary energy supplies reflect end-user energy consumption increases; supplies continued to grow at a substantial rate until fiscal 1973, but leveled off after the first oil crisis, then began to shrink until 1986, when there was again a surge of growth; in fiscal 1990, Japan's total primary energy supply was the equivalent of 526 million kiloliters (486,308 10^{10} kcal) of oil.

Oil supplies grew continually during phase I, shrank during phase II, and again grew steadily during phase III; the total supply was less in fiscal 1990 than in 1973. Coal supplies are increasing very gradually. Supplies of natural gas and nuclear energy are growing at a substantial rate.

Figure 7-5 Total Primary Energy Supply

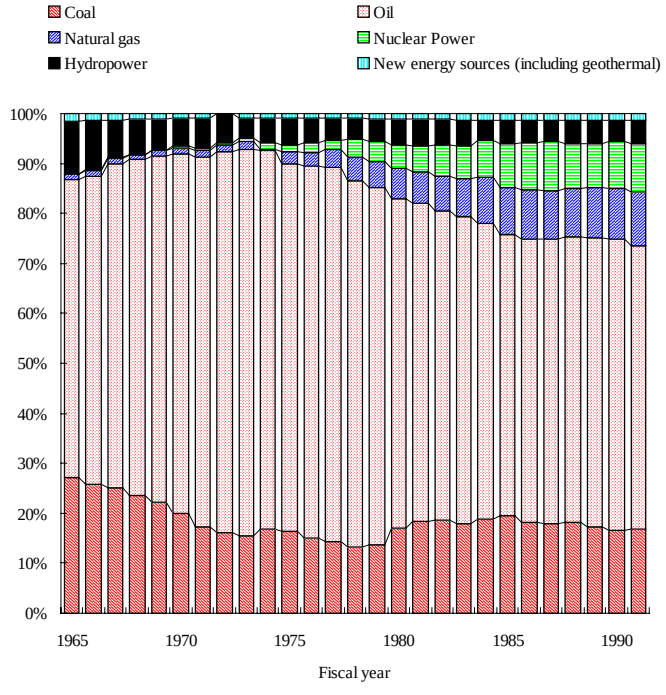


		FY1973	FY1990
New Energy sources (including geothermal)	:	3.5	6.8
Hydropower	:	15.8	20.4
Nuclear Power	:	2.3	45.7
Natural Gas	:	5.8	49.1
Oil	:	298.3	283.5
Coal	:	59.7	80.7

(10^{13}kcal

Source: Comprehensive Energy Statistics, MITI.

Figure 7-6 Different Energy Sources' Contributions to Total Primary Energy Supply



		FY1973	FY1990
New Energy sources (including geothermal)	:	0.9%	1.4%
Hydropower	:	41.1%	4.2%
Nuclear Power	:	0.6%	9.4%
Natural Gas	:	1.5%	10.1%
Oil	:	77.4%	58.3%
Coal	:	15.5%	16.6%

Source: Comprehensive Energy Statistics, MITI.

Different energy sources contribute different shares of the total primary energy supply: during phase I, oil increased its share while coal and hydroelectric power decreased theirs. As a

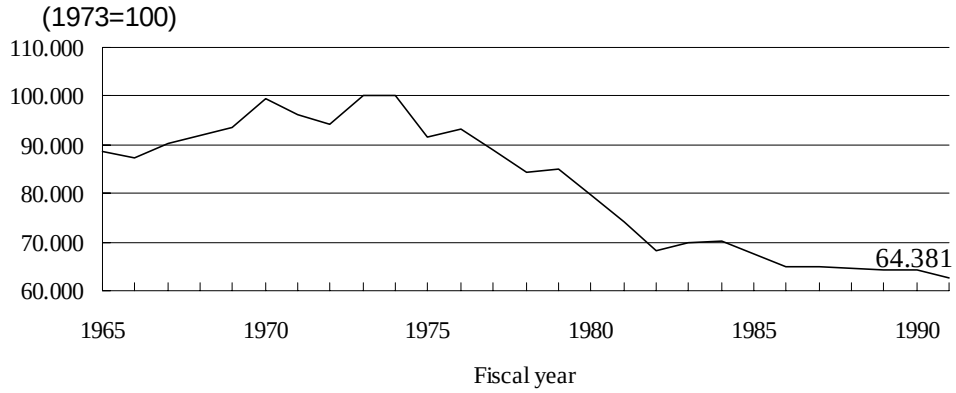
result, oil's share of total primary energy (the "oil dependency" rate) rose to a peak at 77 percent in fiscal 1973. Oil's share then began to decrease during phase II, and it bottomed out during phase III. As of fiscal 1990, it was 58 percent. Coal gradually increased its share following the second oil crisis in 1979 but has remained basically level; in fiscal 1990, its contribution was about 17 percent. The introduction of alternatives to oil beginning in fiscal 1973 swiftly increased the shares of natural gas and nuclear power, to approximately 10 percent and 9 percent respectively in fiscal 1990.

7-3. Per capita energy consumption and total primary energy supply per unit GNP

Japan's annual per capita energy consumption is the equivalent of 4,250 liters of oil (about 39.3 million kcal), extremely low for an advanced industrial nation.

Japan's total primary energy supply per unit of GNP, a measure of how efficiently energy is used to produce goods and services, worsened during phase I but has improved since phase II. Though it has tended to improve during phase III also, more recently it has leveled off. This is due both to the significant contribution by industry's massive energy-saving investments to the reduction already achieved in energy input per unit of output and to the increase in residential and commercial and transport energy consumption due to greater national affluence and a higher standard of living. Between 1973 and 1990, energy supply per unit of output improved by roughly 36 percent.

Figure 7-7 Ratio of Primary Energy Supply to Unit GNP



Source: Comprehensive Energy Statistics, MITI; Report on National Accounts, Economic Planning Agency

7-4. Prices

Imported energy was cheap and supplies were plentiful during phase I; prices skyrocketed when the first oil crisis broke out, ending phase I, peaked in fiscal 1981 then began to fall, and have been steady since fiscal 1986. The real price of imported energy (specifically oil) converted to fiscal 1990 yen and adjusted for inflation] using a deflator, has not increased much compared to pre-oil-crisis levels, if it is taken into account that the yen has become considerably stronger over this

interval of time.

Prices of different forms of energy used in Japanese industry and homes are shown in Table 7-1.

Table 7-1 Prices (Including Taxes) and Taxes in 1,000 Yen (1990)

	AUTOMOTIVE FUELS (price per liter)				LIGHT FUEL OIL (price per 1,000 liters)			
	Unleaded Reg.		Autom. Diesel		Industry		Households	
1990	Price	Tax	Price	Tax	Price	Tax	Price	Tax
	0.125	0.057	0.074	0.026	35.87	1.04	46.26	1.35

	HEAVY FUEL OIL (price per metric ton)				ELECTRICITY (average price per kilowatt hour)			
	Industry		Electr. Gen.		Industry		Households	
1990	Price	Tax	Price	Tax	Price	Tax	Price	Tax
	27.19	0.79	29.99	n.a.	0.0182	0.001	0.0264	0.0015

	NATURAL GAS (average price per 107 kilocalories GCV)						STEAM COAL (price per metric ton)			
	Industry		Electr. Gen.		Households		Industry		Electr. Gen.	
1990	Price	Tax	Price	Tax	Price	Tax	Price	Tax	Price	Tax
	59.74	1.74	24.2	n.a.	136.98	3.99	9.97	0.29	13.64	0.4

	COOKING COAL (price per metric ton)	
	Industry	
1990	Price	Tax
	9.23	0.27

Source: Energy Prices and Taxes, Third Quarter 1992, OECD/IEA.

8. The Government and Administration

Under the 1947 Japanese Constitution, sovereign power resides with the people and judicial, legislative, and executive powers of government are vested respectively in the mutually independent Supreme Court, Diet, and Cabinet. The Constitution establishes a parliamentary cabinet linking the Cabinet to the Diet: the Diet designates the Prime Minister; the Prime Minister and a majority of Ministers of State must be Diet members, and the Cabinet is collectively responsible to the Diet.

The Japanese Diet is the highest organ of State power and the sole law-making organ of the State. It consists of two houses, the House of Representatives and the House of Councilors. A bill becomes a law upon passage by both houses of the Diet. Bills may be proposed either by Diet members or by the Cabinet. In addition, the Diet approves the conclusion of treaties and approves the budget and the handling of finances every fiscal year; it receives reports from the Cabinet on general affairs of State and foreign relations and the state of the national finances. Both houses of the Diet may investigate matters related to national policy.

The Cabinet consists of the Prime Minister, who is its head, and of no more than twenty Ministers of State appointed by the Prime Minister. Official Cabinet decisions are made in Cabinet meetings.

As organs of national administration under Cabinet jurisdiction are established the Prime Minister's Office and (currently) twelve ministries: Justice; Foreign Affairs; Finance; Education, Culture and Science; Agriculture, Forestry, and Fisheries; International Trade and Industry; Transport; Posts and Telecommunications; Health and Welfare; Labor; Construction; and Home Affairs. To administer their work, the Prime Minister's Office and government ministries have established external agencies and organs, of which there are 31. Those similar in nature to a ministry are placed under the direction of a Minister of State; such agencies include the National Public Safety Commission, the Management and Coordination Agency, the Hokkaido Development Agency, the Defense Agency, the Economic Planning Agency, the Science and Technology Agency, the

Environment Agency, the Okinawa Development Agency, and the National Land Agency.

Global environmental problems, including global warming, are addressed by closely coordinating policies among the administrative organs most closely concerned. To ensure effective overall coordination, the Cabinet has decided to hold the Council of Ministers for Global Environment Conservation. Non-Cabinet members may be asked, if necessary, to attend these meetings, which are intended to be a forum for the free exchange of opinions and information. Experts may also be asked to attend these meetings to present their views regarding global environmental protection. This Cabinet meeting makes decisions on the Japanese Government's Action Program To Arrest Global Warming which is the national program of Japan; under this program, annual reports are submitted to the meeting about the status of implementation of its environmental policies, based on which it examines ways to further promote the action plan.

Councils are among the representative organs established under laws and ordinances with the object of ensuring that specialists' knowledge and people's views are reflected in administrative actions. The main duty of councils and other advisory bodies is to investigate and deliberate on the jurisdiction and stipulations of laws and ordinances and inform administrative organs of their views. At the end of fiscal 1993 there were 214 councils and similar organs in existence.

As of March 31, 1992, local public entities included 47 prefectures and 3,237 municipalities (cities, towns, and villages); local assemblies serve as their legislature; their executive branches are headed by a Governor in the case of prefectures and by a Mayor in the case of municipalities. Prefectures and municipalities carry out their own affairs as well as the duties entrusted to them by the national government.

9. Finances

Japan's national finances are administered as follows: every fiscal year (April 1 to March 31) the government prepares a budget which must be approved by the Diet before it is implemented by the executive branch. The national budget consists of three parts: the general account, special accounts, and government-related operating accounts. In addition, fiscal investment and loan are made as determined by fund investment plans established in the course of budget preparation.

The general account is the record of the national government's ordinary revenues and outlays. Sources of funds are taxes and, when necessary, national borrowing. This account covers the most basic national expenses. Special accounts are specially established under the Finance Law independently of the general account in cases where the national government runs certain enterprises, invests certain funds, or allots certain revenues to certain expenditures. There are 38 such special accounts, including the Special Accounts for Government Enterprises, the Special Accounts for Food Controls, and the Special Account for Insurance. Government-related operations are wholly state-owned national enterprises established via special legislation; People's Finance Corporation, Japan Finance Corporation for Small Business, and the Japan Development Bank are among the nine finance corporations and two banks set up in this way. They are special corporations with independent juridical status granted by the national government in order to facilitate flexible budgeting and increase the efficiency of their corporate management. Fiscal investment and loan use postal savings, employees' pension insurance premiums, and other public funds gathered through the national government's credit and savings

institutions as the basis for making investments in and loans to the national government's special accounts, finance corporations, public corporations, and other corporations and agencies as well as loans to local public bodies.

In the general account, about 675.9 billion yen was appropriated for energy programs in fiscal 1994, compared to about 655.1 billion yen the preceding fiscal year. A total of about 1,283.0 billion yen was appropriated for all energy programs, including special accounts for programs to promote electric power development and to upgrade the supply and demand structure of coal, oil, and energy, compared to about 1,269.7 billion yen during the previous year.

In the special account for the above-mentioned electric power development promotion program, about 416.2 billion yen was appropriated in fiscal 1994 to systematically promote the siting of electric power plants and the development of oil-substitute energy technologies.

The special account for the above-mentioned program to upgrade the supply and demand structure of coal, oil, and energy is being expanded beginning in fiscal 1993. It was decided to start new energy-saving programs in addition to past oil-substitute energy programs, and in the framework of the program to upgrade the supply and demand structure of energy, about 92.9 billion yen was appropriated in fiscal 1994 to promote oil-substitute energy technology and energy-saving technology development, formation of environmentally harmonious energy systems for local communities, international energy-saving programs, conversion to oil-substitute energy equipment and energy-saving equipment, and solar energy systems. In addition, the global environmental protection-related component, either having global environmental protection as a direct goal or contributing especially significantly to global environmental protection, was allocated about 548.1 billion yen in fiscal 1994 (compared to about 534.4 billion yen in fiscal 1993); the global warming countermeasures program accounted for about 410.9 billion yen of this total.

Table 9-1 Revenue and Expenditure in the Fiscal 1994 General Account (Units: 100 Million Yen and Percent)

	Budgeted Amounts in Fiscal 1994			Budgeted Amounts in Fiscal 1993 (Beginning)		
		Increment or decrement	Percentage change		Increment or decrement	Percentage change
Revenue						
1. Tax and Stamp Income	536,650	-76,380	-12.5	613,030	-12,010	-1.9
2. Other Income	57,737	28,519	97.6	29,218	4,878	20.0
(1) Receipts from National Debt Consolidation Fund Special Account	1,725	-141	7.5	1,866	-300	13.9
(2) Other Income	56,012	28,660	104.8	27,352	5,178	23.4
3. Revenue from Sale of Public Bonds	136,430	55,130	67.8	81,300	8,500	11.7
Total	730,817	7,269	1.0	723,548	1,368	0.2
Expenditure						
1. National Debt Service Expenditure	143,602	-10,821	-7.0	154,423	-10,050	6.1
2. Revenue Sharing Payments to Prefectural Governments	127,578	-28,596	18.3	156,174	-1,545	1.0
3. Transfer to Industrial Investment Special Account	35,641	21,858	158.6	13,783	783	6.0
4. Ordinary Expenditure	408,548	9,380	2.3	399,168	12,180	3.1
5. Return settlement transfer to compensate for shortfall in fiscal 1992	15,448	15,448	all increase	-	-	-
Total	730,817	7,269	1.0	723,548	1,368	0.2

Note: Some discrepancies originate from differences in statistical data handling.

Bibliography

UNCED Report

Census, Statistics Bureau, Management and Coordination Agency

Annual Report on National Accounts, Economic Planning Agency

Report on Housing Statistics Survey, Bureau of Statistics Management and Coordination Agency

Analyses of Industrial Production Activity, Research and Statistics Department, Secretariat of the Minister for International Trade and Industry

IEA Statistics, Energy Prices and Taxes, OECD/IEA

Japan Statistics 1992/93, Statistics Bureau, Management and Coordination Agency

Mini-Statistics Handbook, Statistics Bureau, Management and Coordination Agency

Statistical Handbook of Japan, Statistics Bureau, Management and Coordination Agency

Japanese Meteorological Tables, Meteorological Agency

Annual Report on the National Land, National Land Agency

Annual Report on Agricultural Trends, Ministry of Agriculture, Forestry, and Fisheries

Annual Report on Forestry Trends, Ministry of Agriculture, Forestry, and Fisheries

Annual Report on the Pollution Situation, Environment Agency

Annual Report on the Economy, Economic Planning Agency

Transport Economics Annual Report, Ministry of Transport

Land and Construction Today, Ministry of Construction

Health and Welfare White Paper, Ministry of Health and Welfare

The Report of National Land toward the Balanced Development, National Land Agency

Global Warming Monitoring Report, Japan Meteorological Agency

Japan's Estimated Future Population, Demographics Institute, Ministry of Health and Welfare

Waste Disposal in Japan, Waste Management Division, Water Supply and Environmental Sanitation Department, Environmental Sanitation Bureau, Ministry of Health and Wealth

Handbook of National Land Policy, National Land Agency.

Statistical Trends in Land Transport, Japan Automobile Chamber of Commerce.

The Fourth National Comprehensive Development Plan (Theory and Data), Planning and Coordination Bureau, National Land Agency.

Japan's Finance (Chart), Takao Hotta

Course and Prospects of Japan's Energy Policy, Agency of Natural Resources and Energy

Post-War Japanese Economy Journal, Japan Productivity Center

Second Comprehensive Traffic Report: Nationwide Traffic Network, Yoshinosuke Yasojima, High Mobility Network Association

Statistical Trends in Construction, Ministry of Construction

Chapter 2

National Inventory of Greenhouse Gas Emissions and Removals

1. Basic Approach

The following approach was taken in compiling this inventory, based on the Guidelines for the Preparation of First Communications by Annex I Parties.

1-1. Target Year

This inventory targets Japan's fiscal year 1990 (April 1990-March 1991). This time frame was chosen because most of the data used to calculate greenhouse gas emissions and removals are totalized in fiscal-year units, which begin on April 1 and end on March 31 of the following year.

1-2. Targeted Greenhouse Gases

Emissions were estimated for the following greenhouse gases: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O); and precursors: nitrogen oxides (NOx), carbon monoxide (CO), and non-methane volatile organic compounds (NMVOC). Removals were estimated for carbon dioxide. Emissions and removals were estimated for these gases according to the categories established by the IPCC/OECD Draft Guidelines.

Because there are some uncertainties of emission status of other greenhouse gases (PFCs, HFCs, SF_6), they have not been included in this inventory, although little amount of these gases was estimate to be emitted in fiscal 1990. Efforts will be made, however, to improve our scientific knowledge concerning these gases and provide a report about them at a future date.

1-3. Calculating Method

Greenhouse gas emissions and removals have been calculated in essentially the same way as outlined in the IPCC/OECD Draft Guidelines, with emission and removal factors (unit requirements of gas emissions and removals over a one-year period) estimated for each source or sink within each category, and multiplied by fuel consumption and other activity data. Significant figures were taken into account in the estimates. Concerning nitrogen oxides emissions from soot and smoke emitting facilities under Air Pollution Control Law, the emissions from a facility-by-facility basis were collected into total emissions.

Emission and removal factors were in principle derived from the results of research conducted in Japan, with IPCC/OECD default values used when the Japanese data proved insufficient. Values for fuel consumption and other activity data were in principle based on Japanese government statistics.

Currently, emission/removal factors and activity data needed to estimate emissions and removals are insufficient in certain categories. Improvement in these fields will be possible as more information is acquired and as international trends develop.

1-4. Greenhouse Gas Source and Sink Categories, and Quality of Estimates

Table 2--2--1 shows the greenhouse gas source and sink categories used in this inventory, based on

the IPCC/OECD Draft Guidelines and on conditions particular to Japan. The table also shows the quality of the emission and removal based on the accuracy of emission/ removal factors and activity data.

Table 2-1-1 Greenhouse Gas Source and Sink Categories, and Quality of Estimates

Categories	CO2		CH4		N2O		NOx		CO		NMVOC	
	Estimate	Quality	Estimate	Quality	Estimate	Quality	Estimate	Quality	Estimate	Quality	Estimate	Quality
Total National Emission and Sink		H		M		L		H		L		L
1. All Energy												
A. Fuel Combustion	ALL	H	ALL	L	PART	L	ALL	H	ALL	L	PART	L
B. Fugitive Fuel Emission	NE	-	PART	M	NE	-	NE	-	NE	-	ALL	L
2. Industrial Processes	PART	H	NE	-	PART	L	PART	H	NE	-	PART	L
3. Solvent and Other Product Use	NE	-	NE	-	NE	-	NE	-	NE	-	ALL	L
4. Agriculture												
A. Enteric Fermentation	NA	-	ALL	H	NA	-	NA	-	NA	-	NA	-
B. Animal Wastes	NA	-	ALL	L	NA	-	NA	-	NA	-	NA	-
C. Rice Cultivation	NA	-	ALL	M	NE	-	NA	-	NA	-	NA	-
D. Agricultural Soils	NA	-	NE	-	ALL	M	NA	-	NA	-	NA	-
E. Agricultural Waste Burning	NE	-	PART	M	PART	M	NE	-	NE	-	NE	-
F. Savanna Burning	NA	-	NA	-	NA	-	NA	-	NA	-	NA	-
5. Land Use Change & Forestry	PART	M	NE	-	NE	-	NE	-	NE	-	NA	-
6. Waste	ALL	M	PART	M	PART	M	ALL	H	ALL	L	NE	-

(Estimates)
ALL: Full estimate of all sources and sinks.
PART: Partial estimate.
NA: Not applicable.
NE: Not estimated.

(Quality)
H: High confidence in estimation.
M: Medium confidence in estimation.
L: Low confidence in estimation.

1-5. Bunker Oil

Carbon dioxide emissions from the burning of bunker oil are not included in domestic emissions and are therefore estimated separately.

1-6. Biomass

Estimates of carbon dioxide emissions from biomass are included in the calculations as part of the non-fossil fuel and waste categories; correspondently with this, carbon dioxide removals under the managed forests category include the removals attributed to harvested volume.

It is thought that yearly removals offset yearly fixed amounts for a part of the biomass mentioned above.

1-7. Converting to Calorific Values

The following conversion values are used to calculate the calorific value of crude oil: 9,250 kcal/l; 1 cal = 4.19J.

2. National Inventory of Greenhouse Gas Emissions and Removals

Japan's national inventory of greenhouse gas emissions and removals for fiscal 1990 is shown in Table 2-2-2 below.

Table 2-2-2 National Greenhouse Gas Inventory (Fiscal 1990)

Unit: Gg

Category	CO2	CH4	N2O	NOx	CO	NMVOC
Total National Emissions	1,173,000	1,380	48	1,898	2,809	2,060
I. Energy	1,075,000	125	22	1,844	2,792	560
A. Fuel Combustion	1,075,000	25	22	1,844	2,792	340
1. Energy & Transformation Industries	82,000	2	5	388	126	40
2. Industry (including Agriculture/Forestry)	489,000	8	4	393	306	20
3. Commercial/Institutional	123,000	0.5	NE	16	5	NE
4. Residential	139,000	0.5	0.1	38	25	NE
5. Transport	215,000	14	13	1,009	2,330	280
6. Other	9,000	NE	NE	NE	NE	NE
7. Biomass Burned for Energy	18,000	NE	NE	NE	NE	NE
B. Fugitive Fuel Emissions	NE	100	NE	NE	NE	220
1. Oil and Natural Gas Systems	NE	NE	NE	NE	NE	220
2. Coal Mining	NA	100	NA	NA	NA	NE
II. Industrial Processes	53,000	NE	15	1	NE	60
A. Chemicals	NE	NE	15	1	NE	60
B. Non-metallic Mineral Products	43,200	NE	NE	NE	NE	NE
C. Other	9,800	NE	NE	NE	NE	NE
III. Solvent Use	NE	NE	NE	NE	NE	1,440
IV. Agriculture	NE	790	5	NE	NE	NE
A. Enteric Fermentation	NA	330	NA	NA	NA	NA
B. Animal Wastes	NA	190	NA	NA	NA	NA
C. Rice Cultivation	NA	261	NE	NA	NA	NA
D. Agricultural Soils	NA	NE	4	NA	NA	NA
E. Agricultural Waste Burning	NA	6	1	NE	NE	NE
F. Savanna Burning	NA	NA	NA	NA	NA	NA
V. Land Use Change & Forestry	IE*	NE	NE	NE	NE	NE
A. Forest Clearing & On-Site Burning of Cleared Forests	NE	NE	NE	NE	NE	NA
B. Grassland Conversion	NE	NA	NA	NA	NA	NA
C. Managed Forests	IE*	NA	NA	NA	NA	NA
D. Abandonment of Managed Lands	NE	NA	NA	NA	NA	NA
VI. Wε ##	465	6	53	17	NE	
A. Landfills	1,000	446	NA	NA	NA	NA
B. Wastewater	NA	6	NE	NA	NA	NA
C. Other	44,000	13	6	53	17	NE
International Bunker Oil	31,000	NE	NE	NE	NE	NE
Total Removals (Managed Forests)	90,000	NA	NA	NA	NA	NA

Code Meaning

NA : Not applicable.

NE : Not estimated.

IE : Estimated but included elsewhere.

* : Estimated taking into account removals in sink data

3. Carbon Dioxide

3-1. Total Carbon Dioxide Emissions

Carbon dioxide is produced through the burning of fuels and waste, the chemical reaction of limestone and other materials, the organic decomposition of waste in landfills and so forth. In conformity with the emission sources indicated in the IPCC/OECD Draft Guidelines, carbon dioxide emissions in this inventory have been calculated for the following categories: 1) Energy (Fuel Combustion); 2) Industrial Processes (chemical reaction of limestone, etc.); and 3) Waste

(incineration, etc.). Because Japan has not recently experienced any major changes in land use, no calculations were made concerning carbon dioxide emissions in the following categories: Forest Clearing; Grassland Conversion; and Abandonment of Managed Lands.

According to the calculation methods described in section 3-2 below, total carbon dioxide emissions amounted to 1,173,000 Gg-CO_2 (320 million tons of carbon) in fiscal 1990, broken down by specific source as shown in Table 2-3-1.

Table 2-3-1 Carbon Dioxide Emissions in Fiscal 1990

Emission Source			Emissions (Gg-CO2)
Energy	Fossil Fuel Combustion		1,057,000
		Energy & Transformation Industries	82,000
		Industry	489,000
		Commercial/Institutional	123,000
		Residential	139,000
		Transport	215,000
		Other	5,000
		Statistical Error	4,000
	Non-fossil Fuel Combustion (Biomass Burned for Energy)		18,000
Industrial Processes			53,000
Waste			45,000
Total Emissions			1,173,000

3-2. Carbon Dioxide Emissions by Sector

3-2-1. Energy (Fossil Fuel Combustion)

Japan has a highly detailed grasp of the amount of carbon dioxide emissions generated by fuel combustion. Therefore, this inventory was compiled using the same top-down calculating methods that have already been used to determine emissions separately for fossil and non-fossil fuel combustion as part of the Japanese government's Action Program To Arrest Global Warming. For detailed sources within the fossil fuel combustion category, a bottom-up calculating method was used.

(1) Fossil Fuels

* Emissions

In determining the emission factors for carbon dioxide produced through fossil fuel combustion, efforts were made to reflect with as much detail as possible the particular types of fuel that are actually supplied and consumed in Japan[(1)], as shown in Table 2-3-2. The weighted averages for coal and petroleum products were obtained with respect to the total primary energy supply[(2)].

The activity data consist of the domestic energy supply, which is comprised of the following categories: coal, coke, crude oil, petroleum products, and natural gas and LNG. However, supplied energy also contains carbon that is not burned but is

rather used as raw material for chemical products. This carbon content is therefore deducted from the total, based on the assumption that it equals:

5% of the carbon content of coal and petroleum coke consumed to make coke.

80% of the carbon content of fuel materials consumed for Non-Energy Use, and 80% of the carbon content of all naphtha and LPG consumed in the chemical industry. (See Tables 2-3-4 and 2-3-5.)

Table 2-3-2 Emission Factors for Each Type of Fuel

(Unit: Gg-C/10^10 kcal)

Coal	Steam Coal	0.9900	Petroleum Products	Kerosene	0.7748
	Domestic Coking Coal	1.0422		Light Oil	0.7839
	Imported Coking Coal	1.0344		'A' Fuel Oil	0.7911
	Anthracite	1.0344		'B' Fuel Oil	0.8047
	(Average)	1.0062		'C' Fuel Oil	0.8180
Coke		1.2300		Lubricating Oil	0.8047
				Other Petroleum Products	0.8693
Crude Oil		0.7811		Oil Refinery Gas	0.5924
				Petroleum Coke	1.0612
Petroleum Products	Gasoline	0.7658		LPG	0.6833
	Naphtha	0.7605		(Average)	0.7611
	Jet Fuel	0.7665	Natural Gas and LNG		0.5639

Incomplete combustion causes a portion of the carbon content in fuels to be released in such forms as hydrocarbons, carbon monoxide, and soot. For the purposes of this inventory, however, this portion has not been deducted from the carbon dioxide emissions. Following the above, Japan's total carbon dioxide emissions from fossil fuel combustion in fiscal 1990 was 1,057,000 Gg-CO_2, broken down by fuel category as shown in Table 2-3-3.

* Emissions by Sector

Carbon dioxide emissions from fuel combustion were calculated on a sector-by-sector basis as described below.

1) Emissions resulting from the direct combustion of coal, coke, crude oil, petroleum products, natural gas and LNG, and town gas were calculated for the following sectors: Energy & Transformation Industries (including electric utilities, in-house power plant operators, and heat suppliers, as well as in-house consumption and loss); Industry; Commercial/Institutional; Residential; and Transport.

The values shown in Table 2-3-6 were used for the emissions factors, with allowances made for inter-fuel overlap and non-combustion applications(3). Emissions factors for coke and town gas consist of carbon content of the fuels from which they were made, divided by those fuels' respective total caloric content.

The activity data consist of the fuel amounts consumed in each category.

Concerning naphtha and LPG in the chemical industry, carbon dioxide emissions were calculated after reducing the total consumption amount for each fuel by 80% to account for non-combustion use.

Table 2-3-3 Carbon Dioxide Emissions from Fossil Fuel Combustion

Fuel Type	(1)Total Domestic Energy Supply (10^10 kcal)	(2)Emissions Factor (Gg-C/10^10 kcal)	(3) [= (1) * (2) * 44/12] (Gg-CO2)	(4) Deduction (Gg-CO2)	Emissions [(3)-(4)] (Gg-CO2)
Coal	81,706	-1.0062	301,446	9,000*	292,446
Coke, etc.	-1,241	1.23	-5,597	-	-5,597
Crude Oil	215,751	0.7811	617,918	-	617,918
Petroleum Products	48,120	-0.7611	134,288	84,000*	50,288
Natural Gas and LNG	49,276	0.5639	101,885	-	101,885
Total	-	-	1,149,940	93,000	1,057,000

· Figures in parentheses indicate averaged emissions factors.
· Negative numbers in the coke category are due to exports.
· For more detail concerning items marked with an asterisk, consult Tables 2-3-4 and 2-3-5.

Table 2-3-4 Deductions for Non-Combustion Applications

Fuel Type	(1) Emissions Factor (Gg-C/10^10 kcal)	(2) Amount Used to Make Coke (10^10 kcal)	Deduction [= (1) * (2) * 0.05 * 44/12] (Gg-CO2)
Coking Coal	0.99	49,360	9,000
Anthracite, etc.	1.0344	34	6
Petroleum Products (Petroleum Coke)	1.0612	798	160

Table 2-3-5 Deductions for Non-energy Use and Chemical Industry Applications

Category	Fuel Type	(1) Emissions Factor (Gg-C/10^10 kcal)	(2) Amount of Fuel Used (10^10 kcal)	Deduction [= (1) * (2) * 0.80 * 44/12] (Gg-CO2)
Non-energy	Lubricating Oil	0.8047	2,340	5,500
	Other Petroleum Products	0.8693	6,432	16,000
Chemical Industry	Naphtha	0.7605	25,558	57,000
Consumption	LPG	0.6833	2,721	5,500

Table 2-3-6 Average Emissions Factor for Each Fuel Type

Fuel Type	Emissions Factor (Gg-C/10^10 kcal)	Fuel Type	Emissions Factor (Gg-C/10^10 kcal)
Coal	1.0317	Petroleum Products	0.776
Coke, etc.	1.1056	Natural Gas and LNG	0.5639
Crude Oil	0.7811	Town Gas	0.5835

2) Direct-combustion emissions from electric utilities and in-house generating facilities are excluded from total direct-combustion emissions in the Energy & Transformation Industries.

3) Direct-combustion emissions from electric utilities and in-house generating facilities (excluded from 2 above) are distributed among all the other sectors as indirect emissions, according to the amount of electricity each sector

consumes. It is assumed that the commercial and residential sectors receive their electricity supply solely from electric utilities. Total emissions for each sector are obtained by adding indirect emissions to direct-combustion emissions.

Carbon dioxide emissions for each sector calculated according to the above are presented in Table 2-3-1. Discrepancies between the amount of energy supplied and the amount of energy consumed are included in the form of statistical error.

(2) Non-fossil Fuels (Biomass Burned for Energy)

Calculations were also made for carbon dioxide emissions from the combustion of the following non-fossil fuels.

Black liquid and wood fuel used in the textile and paper-pulp industries.

Black liquid and wood fuel used for in-house power generation.

Charcoal, firewood, and OGA-LIGHT (a kind of fuel made of sawdust) used in households.

Different emissions factors were used for each type of fuel[(1)].

The activity data are based on Comprehensive Energy Statistics for the final amounts of consumed energy or input energy included in the "Other" subcategory (excluding trash-fired and solar-thermal power) of the "New Energy, etc." category. However, electricity generated from Top Pressure Recovery Turbine as part of the input energy for in-house power generation (the value obtained by dividing the amount of electricity generated by Top Pressure Recovery Turbine and other generating methods(3) using a generating efficiency rate of 38.1%) is not included.

Based on the above, total carbon dioxide emissions from the combustion of non-fossil fuels amounted to 18,425 Gg in fiscal 1990, broken down by fuel type as shown in Table 2-3-7 below.

Table 2-3-7 Carbon Dioxide Emissions from Non-fossil Fuel Combustion

Fuel Type	Amount of Energy Consumed or Converted (10^10 kcal)		Emissions Factor (Gg-C/10^10 kcal)	Emissions (Gg-CO2)
Black Liquid and Wood Fuel Equivalent	Textiles Manufacturing Paper Pulp Manufacturing In-house Power Generation (Less amounts from Top Pressu Recovery Turbine, etc.)	57 2,708 1,799 1,199	1.0751	17,991
Residential-use Biomass Equivalent	106		1.116	434
Total	-		-	18,425

3-2-2. Industrial Processes

Carbon dioxide emissions from industrial processes specifically include emissions from the chemical reaction of limestone consumed in the iron-and-steel, cement, and quicklime manufacturing processes. The IPCC/OECD Draft Guidelines report that carbon dioxide emissions are also generated during the manufacture of aluminum and other materials, but because Japan does not yet have sufficient information concerning such emissions, they are not included in this inventory.

The emissions factors for the quicklime and iron-and-steel manufacturing processes are derived from chemical formulas based on the assumption that all the amount of the limestone used is pure calcium carbonate that is reduced to calcium oxide and carbon dioxide. The same formulas were used to calculate emissions for the cement manufacturing process, but because the limestone used is only about 96% pure(1), this was factored in to derive the final emissions factor.

The activity data for quicklime and iron-and-steel consist of the amount of limestone sold(2), while those for cement consist of the amount of limestone consumed(3).

Based on the above, total carbon dioxide emissions from industrial processes amounted to 53,000 Gg in fiscal 1990, broken down by process as shown in Table 2-3-8 below.

Table 2-3-8 Carbon Dioxide Emissions from Industrial Processes

Process		Emissions Factor	Activity Data (10^3t)	Emissions (Gg-CO2)
Quicklime Manufacturing	Limestone	0.44 (t-CO2/t-CaCO3)	11,734	5,200
Iron-and-steel Related	Limestone	0.44 (t-CO2/t-CaCO3)	22,375	9,800
Cement	Limestone	0.42 (t-CO2/t-CaCO3)	91,583	38,000
Total		-	-	53,000

3-2-3. Waste

(1) Landfills

Waste buried in final disposal sites gradually decomposes over the course of five to 20 years, producing methane and carbon dioxide. For the purposes of this inventory, however, it is assumed that all the carbon dioxide that will ever be generated by the waste is emitted during the single year in which the waste is buried. In addition, waste is divided into the two categories of municipal waste and industrial waste.

* Municipal Waste

Municipal waste is buried in landfills either directly or after incineration, and generates carbon dioxide from the landfills through subsequent decomposition.

The emissions factor for municipal waste buried directly in landfills is obtained by multiplying the carbon percentage content of the waste (16.1%)(1) by the gas

conversion ratio of organic materials in the landfill (50%)[2] and the proportion of total landfill gas emissions accounted for by carbon dioxide (40%)[2]. The emissions factor for municipal waste buried in landfills after incineration is obtained by multiplying the emissions factor for directly buried waste by the ratio of unburned carbon content (1.1%)[1].

The activity data consist of the amount of organic municipal waste buried directly in landfills[3] and the amount buried after incineration[4].

Based on the above, total carbon dioxide emissions from municipal waste buried in landfills amounted to 744 Gg in fiscal 1990, broken down by waste type as shown in Table 2-3-9 below.

Table 2-3-9 Carbon Dioxide Emissions from Municipal Waste Buried in Landfills

Type	Emissions Factor (kg-CO2/t)	Amount Buried (10^3t)	Emissions (Gg-CO2)
Buried Directly	118.1	5,890	696
Buried After Incineration	1.3	36,680	48
Total	-	-	744

* Industrial Waste

For the purposes of this inventory, industrial waste is defined as the following organic wastes: waste wood, waste paper, waste fibers, animal and plant residues, animal wastes, and dead animals. These are buried in landfills, where they emit carbon dioxide. Although sludge also contains organic constituents, it is not included here because the proportion of organic to inorganic constituents is not clearly known.

The emissions factor consists of the wet-based carbon percentage content[5, 6] (based on the dry-based carbon percentage content and the water percentage content[7] of each type of waste multiplied by the same gas conversion ratio and carbon dioxide ratio used to calculate the emissions factors for municipal waste. The activity data consist of the amounts of each type of industrial waste buried directly in landfills[8].

Based on the above, total carbon dioxide emissions from industrial waste buried in landfills amounted to 240 Gg in fiscal 1990, broken down by waste type as shown in Table 2-3-10.

Table 2-3-10 Carbon Dioxide Emissions from Industrial Wastes Buried in Landfills

Type	Carbon Percentage Content (%)	Water Percentage Content (%)	Emissions Factor (kg-CO2/t)	Final Disposal Amount (10^3t)	Emissions (Gg-CO2)
Waste Paper	45	8	303.6	86	26
Waste Wood	45	38	204.6	562	115
Waste Fibers	45	8	303.6	3	0.9
Animal and Plant Residues	42	80	61.6	168	10
Animal Wastes	42	80	61.6	1,364	84
Dead Animals	42	80	61.6	11	0.68
Total	-	-	-	-	240

(2) Incineration

Carbon dioxide emissions from incinerated waste are also calculated according to the two categories of municipal and industrial waste.

* Municipal Waste

The emissions factor for incinerated municipal waste is calculated by multiplying the carbon percentage content of municipal waste (24.2%)[(1)] by the complete combustion ratio in incineration facilities (98.9%)[(1)].

The activity data consist of the amount of waste incinerated[(4)].

Based on the above, total carbon dioxide emissions from incinerated municipal waste amounted to 32,190 Gg in fiscal 1990, as shown in Table 2-3-11 below.

Table 2-3-11 Carbon Dioxide Emissions from Incinerated Municipal Waste

Emissions Factor (kg-CO2/t)	Incinerated Amount (10^3t)	Emissions (Gg-CO2)
877.6	36,680	32,190

* Industrial Waste

For the purposes of this inventory, incinerated industrial waste is defined as the following wastes, whose incinerated amounts are clearly known: waste paper, waste wood, sludge, waste oil, and waste plastics. The emissions factor for each waste type is calculated on the basis of estimated carbon percentage content[(9)].

The activity data consist of the incinerated amount of total processed industrial waste.

Based on the above, total carbon dioxide emissions from incinerated industrial waste amounted to 11,900 Gg in fiscal 1990, broken down by waste type as shown in Table 2-3-12 below.

Table 2-3-12 Carbon Dioxide Emissions from Industrial Waste Incineration

Waste Type	Emissions Factor (t-CO2/t)	Amount Incinerated (10^3t)	Emissions (Gg-CO2)
Waste Paper	1.7	104	180
Waste Wood	1.7	899	1,530
Sludge	1.1	4,840	5,320
Waste Oil	2.9	984	2,850
Waste Plastics	2.6	753	1,960
Total	-	8,417	11,800

3-3. Emissions from International Bunker Oil

Carbon dioxide emissions generated by fuel combustion on international air and sea routes are calculated separately and not included in domestic carbon dioxide emission totals. The emissions

factors used are shown in Table 2-3-2. The activity data consist of the amounts of the following fuels consumed in fiscal 1990, from among 'shipping and receiving of bonded oil products': jet fuel, kerosene; light oil; and 'A', 'B', and 'C' fuel oil[(1)].

Based on the above, total carbon dioxide emissions from international bunker oil amounted to 31,000 Gg in fiscal 1990, broken down by fuel type as shown in Table 2-3-13 below.

Table 2-3-13 Carbon Dioxide Emissions from International Bunker Oil

Type	Sales to Consumers (kl)	Average Calorific Value (kcal/1)	Emissions Factor (Gg-C/10^10 kcal)	Emissions (Gg-CO2)
Jet Fuel	5,392,083	8,700	0.7665	13,200
Kerosene	5	8,900	0.7748	0
Light Oil	8,960	9,200	0.7839	24
'A' Fuel Oil	499,460	9,300	0.7911	1,300
'B' Fuel Oil	8,422	9,600	0.8047	24
'C' Fuel Oil	5,520,452	9,800	0.818	16,200
Total	-	-	-	31,000

3-4. Carbon Dioxide Removals

Of the various carbon dioxide sinks listed in the IPCC/OECD Draft Guidelines, only the category of managed forests was considered relevant to Japan.

The activity data used to determine net carbon dioxide removals by managed forests consist of the forest growth increment and the amount of forest harvested, multiplied by the carbon percentage content (0.5), the bulk density ($0.45 t/m^3$), and the carbon dioxide conversion factor (44/12). Both kinds of activity data (i.e., amount of growth and amount harvested) are revised using conversion values that take into account the proportion of non-trunk tree parts.

Based on the above, total carbon dioxide removals by managed forests amounted to 90,000 Gg in fiscal 1990, as shown in Table 2-3-14 below.

Table 2-3-14 Carbon Dioxide Removals from Managed Forests

Category	Trunk Volume	Amount of Branch and Root Growth in Relation to Trunk Volume	Amount of Existing Leaves, Branches, and Roots in Relation to Trunk Volume	Activity Data	Carbon Dioxide Removals
Units	10^3m^3	10^3m^3	10^3m^3	10^3m^3	Gg-CO2
Amount of Growth,2)	57,839(1)	38,559 (3) (=(1)* 40/601))		96,398 (5) (=(1)+(3))	80,000(=(5)* 0.5* 0.45 * 44/12)
Amount Harvested,3)	37,613(2)	-	25,075 (4) (=(2)* 40/601))	12,538 (6) (=(2)-(4))	10,000 (=(6) * 0.5 * 0.45 * 44/12)
Total	-	-	-	-	90,000

(Reference Sources)

3-2. Carbon Dioxide Emissions by Sector

3-2-1. Energy (Fossil Fuel Combustion)

1) Environment Agency: "The Estimation of CO_2 Emission in Japan (Definition and Calculation Method of Carbon Dioxide Emission under the Action Program to Arrest

Global Warming)" (1992)

2) Agency of Natural Resources and Energy: "Comprehensive Energy Statistics (Fiscal 1993 Edition)" (1994)

3) Ministry of International Trade and Industry (MITI): "Statistical Yearbook for the Iron and Steel Industry (1991)" (1991)

3-2-2. Industrial Processes

1) Study conducted by MITI

2) MITI: "Statistical Yearbook for Resources (1990)" (1991)

3) MITI: "Statistical Yearbook for the Ceramics and Building Materials Industries (1991)" (1992)

3-2-3. Waste

1) Study conducted by the Ministry of Health and Welfare

2) Watanabe et al: "Primary Screening of Greenhouse Gases Generated by the Biodegradation of Organic Waste," included in a compilation of papers presented at the 13th National Research Conference on Urban Sanitation (1992)

3) Study conducted by the Ministry of Health and Welfare

4) Ministry of Health and Welfare: "Waste Treatment in Japan, Fiscal 1990" (1992)

5) Japan Boiler Association: "Air-pollution Prevention Technologies for Small and Medium-sized Boilers" (1984)

6) Environment Agency: "Report of the Study Committee on Countermeasures Regarding New Fuel Use" (1986)

7) Atsuhiro Honda: "Biomass Energy" (1986)

8) Study conducted by the Ministry of Health and Welfare

9) Environment Agency: "The Estimation of CO_2 Emission in Japan" (1992)

10) Ministry of Health and Welfare: "Survey on Administrative Organization (As of April 1991)" (1994)

3-3. Emissions from International Bunker Oil

1) MITI: "Statistical Yearbook on 1990 Energy Supply and Demand" (1991)

3-4. Carbon Dioxide Removals

1) Survey conducted by the Forestry Agency

2) "Nationwide Forest Plan" (1991)

3) Forestry Agency: "Statistical Handbook of Forestry"

4. Methane

4-1. Total Methane Emissions

Methane is emitted by many means, including: the incomplete combustion of fuels and waste; fugitive fuel emissions generated by fossil-fuel mining operations; and the anaerobic decomposition of organic materials resulting from such activities as agriculture, burial of waste in landfills, and wastewater treatment. In conformity with the emission sources indicated in the IPCC/OECD Draft Guidelines, methane emission sources in this inventory have been calculated for the following categories: 1) Energy (Fuel Combustion and Fugitive Fuel Emissions); 2) Industrial Processes (Chemical Industry); 3) Agriculture (Enteric Fermentation, Rice Cultivation, etc.); and 4) Waste (Landfills, etc.). Also, because Japan has no savannas, no calculations were made of methane emissions from savanna burning as part of the "Agriculture" category.

According to the calculation methods described in section 4-2, total methane emissions amounted to 1,380 Gg in fiscal 1990, broken down by specific source as shown in Table 2-4-1below.

Table 2-4-1 Methane Emissions (Fiscal 1990)

Category		Emissions (Gg-CH4)	Category		Emissions (Gg-CH4)
Energy	Fuel Combustion	25	Agriculture	Enteric Fermentation	330
	Energy & Transformation Industries	2		Animal Wastes	190
	Industry	8		Rice Cultivation	261
	Commercial/Institutional	0.5		Agricultural Waste Burning	6
	Residential	0.5	Waste	Landfills	446
	Transport	14		Incineration	13
	Fugitive Emissions from Coal Mining, etc.	100		Wastewater	6
Industrial Processes		-	Total Emissions		1,380

4-2. Methane Emissions by Sector

4-2-1. Energy (Fuel Combustion)

(1) Energy & Transformation Industries

The methane emissions factors used for the Energy & Transformation Industries (including electric utilities, in-house power generation, heat supply operations, and in-house consumption) consist of the emissions factors for facilities that are considered typical for each type of fuel in each subcategory(1).

The activity data consist of the amounts of each type of fuel consumed in fiscal 1990(2).

Based on the above, total methane emissions from the Energy & Transformation Industries amounted to 2.2 Gg in fiscal 1990, as shown in Table 2-4-2 below. Emissions from electric utilities and in-house power generating facilities are not distributed in terms of the electricity demand of users.

Table 2-4-2 Methane Emissions from the Energy & Transformation Industries

Fuel Type	Emissions Factor (g-CH4/GJ)	Amount of Fuel Consumed (10^10kcal)	Emissions (Gg-CH4)
Coal and Briquette Coal	0.54	19,517	
Crude Oil	0.115	20.245	
Gasoline, Naphtha, and NGL	0.17	1,529	
Kerosene and Light Oil	0.056	374	2.23
Fuel Oil and Petroleum Coke	1.057	33,871	
LNG	0.152	35,947	
LPG	0.027	1,229	
Town Gas	0.28	622	

(2) Industry

Methane emissions factors used in the industry sector (including manufacturing, agriculture, forestry, fisheries, and construction) consist of the emissions factors for facilities that are considered typical for each type of fuel in each subcategory[(1)].

The activity data consist of the amounts of each type of fuel consumed in fiscal 1990[(2)].

Based on the above, total methane emissions from the industry sector amounted to 8.1 Gg in fiscal 1990, as shown in Tables 2-4-3 and 2-4-4.

Table 2-4-3 Methane Emissions from the Manufacturing Sector

Fuel Type	Emissions Factor (g-CH4/GJ)	Amount of Fuel Consumed (10^10kcal)	Emissions (Gg-CH4)
Coal and Briquette Coal	0.54	13,621	
Coke	0.121	19,045	
Crude Oil	0.115	18	
Gasoline, Naphtha, and NGL	0.17	25,808	
Kerosene and Light Oil	0.023	6,765	1.6
Fuel Oil and Petroleum Coke	1.057	21,589	
LNG	0.152	40	
LPG	0.027	8,006	
Town Gas	0.28	3,977	

Table 2-4-4 Methane Emissions from Agriculture, Forestry, Fisheries, and Construction Industries

Category	Fuel Type	Emissions Factor (g-CH4/GJ)	Amount of Fuel Consumed (10^10kcal)	Emissions (Gg-CH4)
Agriculture and Forestry	Light Oil and 'A' Fuel Oil	8.0	4,056	1.4
Fisheries	Light Oil and 'A' Fuel Oil	20.0	4,439	3.7
Construction	Light Oil and 'A' Fuel Oil	8.0	4,134	1.4
Total	-	-	-	6.5

(3) Commercial/Institutional and Residential

Methane emissions factors used in the combined Commercial/Institutional and residential sectors consist of the emissions factors for facilities that are considered typical for each type of fuel in each sector[(1)].

The activity data consist of the amounts of each type of fuel consumed in fiscal 1990[(2)].

Based on the above, total methane emissions from the combined Commercial/

Institutional and residential sectors amounted to 1 Gg in fiscal 1990, broken down by sector and fuel type as shown in Table 2-4-5 below.

Table 2-4-5 Methane Emissions from the Combined Commercial/Institutional and Residential Sectors

	Fuel Type	Emissions Factor (g-CH4/GJ)	Amount of Fuel Consumed (10^10kcal)	Emissions (Gg-CH4)
Commercial/ Institutional	Coal and Briquette Coal	16.16	44	
	Coke	1	701	
	Kerosene and Light Oil	0.15	4,002	0.49
	Fuel Oil and Petroleum Coke	0.6	11,373	
	LPG	1	1,739	
	Town Gas	0.28	3,515	
Residential	Coal and Briquette Coal	16.16	85	
	Kerosene and Light Oil	0.15	10,925	0.49
	LPG	1	6,516	
	Town Gas	0.28	7,764	

(4) Transport

In this inventory, methane emissions from railroads are excluded from the transportation sector because the majority of trains in Japan run on electricity. Ships are also excluded because no emissions factors have been obtained. Therefore, the transportation sector is limited to motor vehicles (passenger cars, trucks, and buses) and aircraft (domestic flights).

The methane emissions factors provided by the IPCC/OECD Draft Guidelines were used for passenger cars that use LPG, trucks, and aircraft (domestic flights). For other passenger cars, data for each fuel type obtained through 10¥15 mode fuel efficiency tests[(3)] were used. The emissions factor used for trucks was also applied to buses.

The activity data for passenger cars represent the distance traveled calculated by multiplying the amount of fuel consumed[(2)(4)] by the fuel mileage. Fuel mileage values provided by the IPCC/OECD Draft Guidelines are used for passenger cars that use LPG and for trucks, while mileage values for other types of passenger cars represent the average values obtained from the tests cited above. For all other types of transportation, the amount of fuel consumed[(2)(4)] was used as activity data.

Based on the above, total methane emissions from the Transport sector amounted to 13.8 Gg in fiscal 1990, broken down by fuel and transportation types as shown in Tables 2-4-6 and 2-4-7 below.

Table 2-4-6 Methane Emissions from Motor Vehicles

Fuel and Transportation Types		Emissions Factor (mg-CH4/km)	Amount of Fuel Consumed (10^3kl)	Fuel Mileage (km/l)	Emissions (Gg-CH4)
Gasoline	Passenger Cars	10.3 (4.93-14.3)*	39,014	14.4 (9.62-20.6)*	5.8
	Trucks	40	5,650	9.4	2.1
Diesel	Passenger Cars	10.6	3,780	19.1	0.8
	Trucks**	60	24,037	2.8	4.0
LPG (Passenger Cars)		20	3,411	11.2	0.8
Total		-	-	-	13.5

* Emissions factors in parentheses represent the range of measured values.
** Includes buses.

Table 2-4-7 Methane Emissions from Aircraft (Domestic Flights)

Category	Emissions Factor (mg-CH4/MJ)	Amount of Fuel Consumed (10^10kcal)	Emissions (Gg-CH4)
Aircraft	2	3,254	0.3

4-2-2. Energy (Fugitive Emissions from Coal Mining)

For the purposes of this inventory, fugitive methane emissions from fossil-fuel mining operations are limited to coal mining. Japan has not developed oil or natural gas resources to any significant degree, and has established mining techniques that prevent fugitive emissions after importation; it is therefore believed that almost no fugitive methane emissions are generated in Japan from the handling of oil or natural gas.

Emissions factors are calculated for underground and open-cut mining, including actual mining operations and post-mining transport and storage processes. The emissions factor for underground mining operations reflects the national average for methane gas density in the mine atmosphere[(1)] (mass conversion at 20¡C, 1 atm., as stipulated from security points of view, with the recovered amount (25%)[(2)] deducted. All other emissions factors reflect the averages of values provided by the IPCC/OECD Draft Guidelines.

The activity data consist of the amount of coal produced through underground and open-cut mining[(3)].

Based on the above, total fugitive methane emissions from coal mining amounted to 100 Gg in fiscal 1990, broken down by mining method and process as shown in Table 2-4-8 below.

Table 2-4-8 Fugitive Methane Emissions from Coal Mining

Mining Method	Emissions Factor (kg-CH4/t)		Amount of Coal Produced (10^3t)	Emissions (Gg-CH4)
Underground	Mining Operations	13 (5.2-39)	6,775	88
	Post-mining Processes	1.6 (0.60-2.68)		11
Open-cut	Mining Operations	0.77 (0.20-1.34)	1,205	0.93
	Post-mining Processes	0.07 (0-0.13)		0.08
Total	-		-	100

Emissions factors in parentheses represent the range of reported values.

4-2-3. Industrial Processes

The IPCC/OECD Draft Guidelines contain methane emissions factors for the manufacturing processes for carbon black, ethylene, and so forth. In Japan, however, methane generated by these processes is used as fuel or otherwise processed so that it does not escape into the atmosphere. Any gas that is emitted outside the system is burned using incinerating equipment that is required by law. Therefore, there are virtually no methane gas emissions into the atmosphere generated by industrial processes in Japan.

4-2-4. Agriculture

(1) Enteric Fermentation

Emissions factors for methane from enteric fermentation are based on values obtained from respiration trials(1) (mass conversion at 20¡C, 1 atm.), on the following representative ruminants: cattle, sheep, and goats.

The activity data consist of the numbers of cattle, pigs, sheep, goats, and horses raised[(2)].

Based on the above, total methane emissions from enteric fermentation amounted to 330 Gg in fiscal 1990, broken down by animal species as shown in Table 2-4-9 below.

(2) Animal Wastes

This inventory uses the emissions factors for animal wastes provided by the IPCC/OECD Draft Guidelines for Eastern Europe. It is believed that actual emissions are less than the calculated amounts because aerobic processing of animal wastes is widely practiced in Japan.

Activity data consist of the numbers of cattle, pigs, chickens, sheep, goats, and horses raised[(2)].

Based on the above, total methane emissions from animal wastes amounted to 190 Gg in fiscal 1990, broken down by animal species as shown in Table 2-4-9.

Table 2-4-9 Methane Emissions from Enteric Fermentation and Animal Wastes

Animal Species	Number of Animals Raised (10^3)	Enteric Fermentation		Animal Wastes	
		Emissions Factor (kg/head/day)	Emissions (Gg-CH4)	Emissions Factor (kg/head/year)	Emissions (Gg-CH4)
Dairy Cattle	2,068	-	-	19	39
Lactating	1,082	0.3	120	-	-
Dry	332	0.17	21	-	-
Heifer (Under Two Years)	654*	0.18	32	-	-
Beef Cattle	2,805	-	-	13	36
Dairy breed	1,073*	0.21	62	-	-
Fattening (One Year and Over)	565	0.17	35	-	-
Fattening (Under One Year)	453**	0.12	9.9	-	-
Breeding Cows	714	0.14	36	-	-
Sheep	30	0.011	0.12	0.28	0.0
Goats	37	0.011	0.15	0.18	0.0
Pigs	11,335	0.0028	12	7	80
Horses	24	0.046	0.4	2.1	0.1
Chickens	331,526	-	-	0.117	38.8
Total	-	-	330	-	190

* Number of animals under six months of age, 25% of total, are deducted from the number of animals for estimation on enteric fermentation.
** Number of animals under six months of age, 50% of total, are deducted from the number of the animals for estimation on enteric fermentation.

(3) Rice Cultivation

The emissions factors for methane generated by rice-paddy fields consist of the average values for each type of soil and fertilizer based on field measurements by closed-chamber method[3].

The activity data consist of the total area of cultivated wetland rice proportionally distributed according to the soil types of rice-paddy fields[4].

Based on the above, total methane emissions from flooded rice cultivation amounted to 261 Gg in fiscal 1990, broken down by soil type as shown in Table 2-4-10 below.

Table 2-4-10 Methane Emissions from Flooded Rice Cultivation

Soil Type	Emission Factor (g-CH4/m^2/year)	Area Under Cultivation (10^7m^2)	Emissions (Gg-CH4)
Alluvial Soil	13.4 (8.0-27.0)	1,486 (72.3%)	199
Volcanic Ash Soil	5.9 (3.6 -9.8)	245 (11.9%)	14
Peaty Soil	22.3 (13.3-44.8)	132 (6.4%)	29
Other	9.6 (5.9-18.4)	193 (9.4%)	19
Total	-	2,055	261

Emissions factors in parentheses represent the range of reported values.

(4) Agricultural Waste Burning

For the purposes of this inventory, methane emissions generated by the burning of agricultural waste consist of emissions from rice straw (associated with wetland rice cultivation), rice chaff, and straw from wheat, barley, oats, and rye.

The emissions factors consist of values obtained by the experiment in which straw and chaff were actually burned[5].

The activity data consist of the amount of burned material, calculated by multiplying the following two factors: 1) the amount of straw and chaff produced;

and 2) their respective incineration ratios, meaning the proportion of the total straw and chaff that is burned. For rice straw and chaff, these factors were obtained through surveys[6], through which the amount of straw and chaff produced were determined and it was also found that the incineration ratio for rice straw is 4%, and that for rice chaff is 30%. Wheat, barley, oats, and rye were assumed to produce the same amount of straw in relation to cultivated area as rice, with the same incineration ratio. These values were then multiplied by the amount of grain harvested[4].

Based on the above, total methane emissions from agricultural waste burning amounted to 5.8 Gg in fiscal 1990, broken down by type of burned material as shown in Table 2-4-11 below.

Table 2-4-11 Methane Emissions from Agricultural Waste Burning

Type		Amount Burned (10^3t)	Emissions Factor (kg-CH4/t)	Emissions (Gg-CH4)
Wetland Rice	Straw	438	4.13	1.81
	Chaff	710	5.25	3.73
Wheat, Barley, Oats, and Rye	Straw	54	4.13	0.22
Total		-	-	5.8

4-2-5. Waste

(1) Landfills

Waste buried in final disposal sites gradually decomposes over the course of five to 20 years, producing methane. For the purposes of this inventory, however, it is assumed that all the methane that will ever be generated by the waste is emitted during the single year in which the waste is buried. In addition, waste is divided into the two categories of municipal waste and industrial waste.

Municipal Waste

Municipal waste is buried in landfills either directly or after incineration, and generates methane from the landfills through subsequent decomposition.

The emissions factors for methane are calculated in the same manner as for carbon dioxide. For municipal waste buried directly in landfills, the emissions factor is derived by multiplying the carbon percentage content of the waste (16.1%)[1] by the gas conversion ratio of organic materials in the landfill (50%)[2] and the proportion of total landfill gas emissions accounted for by methane (55%)[2]. The emissions factor for municipal waste buried in landfills after incineration is derived by multiplying the emissions factor for directly buried waste by the ratio of unburned carbon content (1.1%)[1].

The activity data are identical to those used for carbon dioxide, consisting of the amount of organic municipal waste buried directly in landfills[3] and the amount buried after incineration[4].

Based on the above, total methane emissions from municipal waste buried in landfills amounted to 370 Gg in fiscal 1990, broken down by waste type as shown in Table 2-4-12 below.

Table 2-4-12 Methane Emissions from Municipal Waste Buried in Landfills

Waste Type	Emissions Factor (kg-CH4/t)	Amount Buried (10^3t)	Emissions (Gg-CH4)
Buried Directly	59	5,890	350
Buried After Incineration	0.65	36,680	24
Total	-	-	370

* Industrial Waste

Industrial waste is defined in essentially the same way for methane as for carbon dioxide, and is comprised of the following organic wastes: waste wood, waste paper, dead animals, waste fibers, and animal and plant residues. However, animal wastes are not included here because they have been included under the agriculture category.

The emissions factor consists of the wet-based carbon percentage content[5, 6] (based on the dry-based carbon percentage content and the water percentage content[7] of each type of waste) multiplied by the same gas conversion ratio and methane ratio used to calculate the emissions factors for municipal waste.

The activity data are identical to those used for carbon dioxide, and consist of the amounts of each type of industrial waste buried directly in landfills.

Based on the above, total methane emissions from industrial waste buried in landfills amounted to 76 Gg in fiscal 1990, broken down by waste type as shown in Table 2-4-13.

Table 2-4-13 Methane Emissions from Industrial Wastes Buried in Landfills

Waste Type	Carbon Percentage Content (%)	Water Percentage Content (%)	Emissions Factor (kg-CH4/t)	Final Disposal Amount (10^3t)	Emissions (Gg-CH4)
Waste Paper	45	8	151.8	86	13
Waste Wood	45	38	102.3	562	57
Waste Fibers	45	8	151.8	3	0.5
Animal and Plant Residues	42	80	30.8	168	5.2
Dead Animals	42	80	30.8	11	0.3
Total	-	-	-	-	76

(2) Incineration

Methane emissions from incinerated waste are also calculated according to the two categories of municipal and industrial waste.

Municipal Waste

The methane emissions factors for incinerated municipal waste consist of the averages of actual measurements taken at different types of incinerating

facilities (continuous, semi-continuous, and batch type)[8].

The activity data consist of the amounts of waste incinerated at each type of facility[4].

Based on the above, total methane emissions from incinerated municipal waste amounted to 7.6 Gg in fiscal 1990, broken down by type of incinerating facility as shown in Table 2-4-14 below.

Table 2-4-14 Methane Emissions from Incinerated Municipal Waste

Facility Type	Emissions Factor (g-CH4/t)	Amount Incinerated (10^4t)	Emissions (Gg-CH4)
Continuous	29.7 (-2.15 - 114)	2,693	0.8
Semi-continuous	617 (258 - 975)	296	1.8
Batch	742 (41 - 2,310)	678	5.0
Total	-	-	7.6

Emissions factors in parentheses represent the range of reported values.

Industrial Waste

Industrial waste can be incinerated using either semi-continuous or batch-type incinerators. Since it is not known what proportion of the waste the two types respectively incinerate, the emissions factor is calculated by averaging the emissions factors given for the two types as they appear in the municipal waste category.

The activity data consist of the proportion of total processed industrial waste that is incinerated[9].

Based on the above, total methane emissions from incinerated industrial waste amounted to 5.2 Gg in fiscal 1990, broken down by waste type as shown in Table 2-4-15 below.

Table 2-4-15 Methane Emissions from Industrial Waste Incineration

Waste Type	Amount Incinerated (10^3t)	Emissions Factor (g-CH4/t)	Emissions (Gg-CH4)
Waste Paper	104	680 (For All Waste Types)	0.07
Waste Wood	899		0.61
Sludge	4,840		3.3
Waste Oil	984		0.67
Waste Plastics	753		0.51
Total	-	-	5.2

(3) Wastewater Treatment

Methane is produced under anaerobic conditions as part of the wastewater treatment process. The emission factor for methane produced in this way consists of the average of values obtained through measurements taken at actual wastewater treatment facilities[10].

The activity data represent the amount of wastewater treated[11].

Based on the above, total methane emissions from wastewater treatment processes amounted to 6.0 Gg in fiscal 1990, as shown in Table 2-4-16 below.

Table 2-4-16 Methane Emissions from Wastewater Treatment Processes

Emissions Factor (mg-CH4/m^3)	Amount of Wastewater Treated (10^8m^3)	Emissions (Gg-CH4)
582.2 (263.6 - 900.7)	103	6.0

(Reference Sources)

4-2-1. Energy (Fuel Combustion)

1) Environment Agency: "Survey Report on the Analyses of Methane and Other Emissions" (1990)
2) Agency of Natural Resources and Energy: "Comprehensive Energy Statistics (Fiscal 1993 Edition)" (1994)
3) Environment Agency: "Survey Report on Countermeasures for Greenhouse Gas Emissions from Automobiles" (1992)
4) Ministry of Transport: "Transport Energy Handbook, 1992 Edition" (1992)

4-2-2. Energy (Fugitive Emissions from Coal Mining)

1) National Research Institute for Pollution and Resources, Ministry of International Trade and Industry (MITI): "Source Inventory of Industrial Facilities," from Global Environmental Research of Japan in fiscal 1990 (1991)
2) Study conducted by MITI
3) MITI: "Statistical Yearbook on 1990 Energy Supply and Demand" (1991)

4-2-3. Industrial Processes

1) MITI: "1992 Statistical Yearbook on the Chemical Industry"

4-2-4. Agricultural

1) National Institute of Animal Industry, Ministry of Agriculture, Forestry and Fisheries: "Methane Production in Ruminants," from Global Environmental Research of Japan in fiscal 1992 (1993)
2) Statistics Bureau, Management and Coordination Agency: "Japan Statistical Yearbook, 1993-94" (1993)
3) National Institute of Agro-Environmental Sciences, Ministry of Agriculture, Forestry and Fisheries: "Emission of Methane and Nitrous Oxide from Agricultural Land," from Global Environmental Research of Japan in fiscal 1992 (1993)
4) Ministry of Agriculture, Forestry and Fisheries: "Basic Survey on Preserving Soil Fertility, Fiscal 1988"

5) National Institute for Environment Studies, Environment Agency: "Study on Methane and Nitrous Oxide Emissions from Biomass Burning," from Global Environment Research of Japan in fiscal 1991 (1992)
6) Study conducted by the Ministry of Agriculture, Forestry and Fisheries

4-2-5. Waste

1) Study conducted by the Ministry of Health and Welfare
2) Watanabe et al: "Primary Screening of Greenhouse Gases Generated by the Biodegradation of Organic Waste," included in a compilation of papers presented at the 13th National Research Conference on Urban Sanitation (1992)
3) Study conducted by the Ministry of Health and Welfare
4) Ministry of Health and Welfare: "Waste Treatment in Japan, Fiscal 1990" (1992)
5) Japan Boiler Association: "Air-pollution Prevention Technologies for Small and Medium-sized Boilers" (1984)
6) Environment Agency: "Report of the Study Committee on Countermeasures Regarding New Fuel Use" (1986)
7) Atsuhiro Honda: "Biomass Energy" (1986)
8) Institute of Public Health, Ministry of Health and Welfare: "Quantitative Study on Greenhouse Gases Emitted from Solid Waste Disposal Facilities," from Global Environmental Research of Japan in fiscal 1992 (1993)
9) Ministry of Health and Welfare: "Survey on Administrative Organization (As of April 1991)" (1994)
10) Public Works Research Institute, Ministry of Construction: "Study on Amounts of Methane and Nitrous Oxide Release from Wastewater Treatment Plant," from Global Environmental Research of Japan in fiscal 1992 (1993)
11) Ministry of Construction: "1990 Wastewater Statistics (Administrative Edition)"

5. Nitrous Oxide

5-1. Total Nitrous Oxide Emissions

Nitrous oxide is produced in many ways, including: the combustion of fuels and waste; biological reactions to nitrogenous fertilizers in fertilized soil; and as a by-product of manufacturing processes. In conformity with the emission sources indicated in the IPCC/OECD Draft Guidelines, nitrous oxide emissions in this inventory have been calculated for the following categories: 1) Energy (Fuel Combustion); 2) Industrial Processes (Chemical Industry, etc.); 3) Agriculture (Fertilizers); and 4) Waste (Incineration). Because Japan has no savannas, no calculations were made of nitrous oxide emissions from savanna burning as part of the "Agriculture" category.

According to the calculation methods described in section 5-2, total nitrous oxide emissions amounted to 48 Gg in fiscal 1990, broken down by specific source as shown in Table 2-5-1.

Table 2-5-1 Nitrous Oxide Emissions (Fiscal 1990)

Category			Emissions (Gg-N2O)
Energy	Fuel Combustion		22
		Energy & Transformation Industries	5
		Industry	4
		Commercial/Institutional	0.1
		Transport	13
Industrial Processes			15
Agriculture	Fertilizers		4
	Agricultural Waste Burning		1
Waste	Incineration		6
Total Emissions			48

5-2. Nitrous Oxide Emissions by Sector

5-2-1. Energy (Fuel Combustion)

(1) Energy & Transformation Industries

The nitrous oxide emissions factors used for the Energy & Transformation Industries (including electric utilities, in-house power generation, heat supply operations, and in-house consumption) are based on actual measurements of the density of nitrous oxide in the emissions from typical combustion facilities. These measurements were used to obtain a weighted average for gas emissions for each type of fuel and application[(1)]. Fuels were divided into the following categories: solid fuel (coal, coke, briquette coal, and petroleum coke); liquid fuel (crude oil, NGL, gasoline, naphtha, kerosene, light oil, and fuel oil); and gaseous fuel (natural gas, LNG, town gas, LPG, coke-furnace gas, blast-furnace gas, converter gas, and oil-refinery gas).

The activity data consist of the amounts of each type of fuel consumed in fiscal 1990[(2)]. Among boiler applications for solid fuel, the density of nitrous oxide in emissions from coal-fired fluidized bed boilers is particularly high; therefore, the amount of fuel used for each type of boiler is calculated according to the proportion of total steam produced by each type (5.8% in the case of fluidized bed boilers)[(3)].

Based on the above, total nitrous oxide emissions from the Energy & Transformation Industries amounted to 4.7 Gg in fiscal 1990, broken down by fuel type as shown in Table 2-5-2 below. Emissions from electric utilities and in-house power generating facilities are not distributed in terms of the electricity demand of users.

Table 2-5-2 Nitrous Oxide Emissions from the Energy & Transformation Industries

	Emissions Factor (g/GJ)	Amount of Fuel Consumed (1013J)	Emissions (Gg-N2O)
Solid Fuel (Boiler)	0.83	80,254	0.67
(Fluidized Bed Boiler)	53.1	4,941	2.62
Liquid Fuel	0.19	231,301	0.44
Gaseous Fuel	0.4	239,731	0.96
Total	-	-	4.7

(2) Industry

Nitrous oxide emissions in the Industry are divided into two subcategories: those from the manufacturing sector, and those from the combined agriculture, forestry, fisheries, and construction sectors.

Manufacturing

The emissions factors for the manufacturing sector are calculated in the same way as for the Energy & Transformation Industries. They are based on actual measurements of the density of nitrous oxide in the emissions from typical combustion facilities, which were then used to obtain a weighted average for gas emissions for each type of fuel and application[(1)]. The composition of fuel types is also the same as the Energy & Transformation Industries.

The activity data consist of the amounts of different types of fuel used[(2)], with distributed values based on the proportion of fuel used in each of three applications: boilers, direct heating, and other[(4)].

Based on the above, total nitrous oxide emissions from the Manufacturing sector amounted to 2.4 Gg in fiscal 1990, broken down by fuel type and application as shown in Table 2-5-3 below.

Table 2-5-3 Nitrous Oxide Emissions from the Manufacturing

		Emissions Factor (g/GJ)	Amount of Fuel Consumed (10^13J)	Emissions (Gg)
Solid Fuel	(Boiler)	0.83	10,417	0.09
	(Direct Heating)	1.93	74,976	1.45
Liquid Fuel	(Boiler)	0.19	70,585	0.13
	(Direct Heating)	2.48	22,039	0.55
	(Other)	1.45	6,474	0.09
Gaseous Fuel	(Boiler)	0.4	16,710	0.07
	(Direct Heating)	0.07	54,949	0.04
	(Other)	0.4	3,037	0.01
Total		-	-	2.4

Agriculture, Forestry, Fisheries, and Construction

The emissions factors provided in the IPCC/OECD Draft Guidelines are used for the combined agriculture, forestry, fisheries, and construction sectors. The activity data consist of the amount of liquid fuel consumed[(2)].

Based on the above, total nitrous oxide emissions from the agriculture,

forestry, fisheries, and construction sectors amounted to 1.5 Gg in fiscal 1990, broken down by sector as shown in Table 2-5-4 below.

Table 2-5-4 Nitrous Oxide Emissions from the Agriculture, Forestry, Fisheries, and Construction

Sector	Emissions Factor (g-N2O/MJ)	Amount of Fuel Consumed (1010kcal)	Emissions (Gg-N2O)
Agriculture and Forestry	0.002	7,053	0.6
Fisheries	0.002	4,559	0.4
Construction	0.002	5,392	0.5
Total	------	------	1.5

(3) Commercial/Institutional

The emissions factor in the Commercial/Institutional applies only to liquid fuel. As in the Energy & Transformation Industries and Manufacturing sectors, it is based on actual measurements of nitrous oxide densities in emissions[(1)]. The composition of fuel types is also the same as the Energy & Transformation Industries and Manufacturing sectors.

The activity data consist of the amounts of liquid fuel consumed[(2)].

Based on the above, total nitrous oxide emissions from the Commercial/ Institutional sector amounted to 0.1 Gg in fiscal 1990, as shown in Table 2-5-5 below.

Table 2-5-5 Nitrous Oxide Emissions from the Commercial/Institutional Sector

	Emissions Factor (g/GJ)	Amount of Fuel Consumed (1013J)	Emissions (Gg)
Liquid Fuel	0.19	64,421	0.12

(4) Transport

In this inventory, nitrous oxide emissions from railroads are excluded from the Transport sector because the majority of trains in Japan run on electricity. Aircraft and LPG-fueled passenger cars are also excluded because no emissions factors have been obtained. Therefore, the Transport sector is limited to motor vehicles (passenger cars, trucks, and buses) and ships (domestic routes).

The nitrous oxide emissions factors provided by the IPCC/OECD Draft Guidelines were used for trucks and ships (domestic routes). For passenger cars, data for each fuel type obtained through 10¥15 mode fuel efficiency tests[(5)] were used. The emissions factor used for trucks was also applied to buses.

The activity data were calculated in the same way as for methane. Data for passenger cars represent the distance traveled calculated by multiplying the amount of fuel consumed[(2)(6)] by the fuel mileage. As with methane, fuel mileage values provided by the IPCC/OECD Draft Guidelines are used for trucks, while mileage values for passenger cars represent the average values obtained from the tests cited

above.

Based on the above, total nitrous oxide emissions from the Transport sector amounted to 13.2 Gg in fiscal 1990, broken down by fuel and transportation types as shown in Tables 2-5-6 and 2-5-7 below.

Table 2-5-6 Nitrous Oxide Emissions from Motor Vehicles

Fuel and Transportation Types		Emissions Factor (mg-N2O/km)	Amount of Fuel Consumed (103kl)	Fuel Mileage (km/l)	Emissions (Gg-N2O)
Gasoline	Passenger Cars	16.8 (0.0 -- 57.9)*	39,014	14.4 (9.62 -- 20.6)	9.4
	Trucks	24	5,650	9.4	1.3
Diesel	Passenger Cars	6.51	3,780	19.1	0.5
	Trucks**	25	24,037	2.8	1.7
Total		------	------	------	12.9

Table 2-5-7 Nitrous Oxide Emissions from Ships (Domestic Routes)

Category	Emissions Factor (mg-N2O/MJ)	Amount of Fuel Consumed (1010kcal)	Emissions (Gg-N2O)
Ships	2	3,625	0.3

5-2-2. Industrial Processes

For the purposes of this inventory, nitrous oxide emissions generated by Industrial Processes are limited to those produced as a by-product in the manufacture of adipic acid from which nylon 66 is made. Nitrous oxide produced as a by-product in the manufacture of nitrocellulose is not included here because the emissions factor is not known.

The value provided in the IPCC/OECD Draft Guidelines (0.3g-N2O/g-adipic acid) is used as the emissions factor.

Because no government statistics are available, the activity data consist of estimated production amounts[(1)] for 1990 based on private surveys.

Based on the above, total nitrous oxide emissions from Industrial Processes amounted to 15 Gg in fiscal 1990, as shown in Table 2-5-8 below.

Table 2-5-8 Nitrous Oxide Emissions from Industrial Process

Category	Emissions Factor (g-N2O/g)	Amount Produced (t)	Emissions (Gg-N2O)
Manufacture of Adipic Acid	0.3	50,000	15

5-2-3. Agriculture

(1) Fertilization

The emissions factor for nitrous oxide from nitrogenous fertilizers spread on soil consists of the average value of emissions per unit of fertilizer, obtained through 10 field tests[(1)].

The activity data consist of Japan's domestic demand for nitrogenous fertilizer[(2)], as measured over the course of the 1990 fertilizing year (July 1990 through June 1991).

Based on the above, nitrous oxide emissions from fertilized soil amounted to 4.0

Gg in fertilizing year 1990, as shown in Table 2-5-9 below.

Table 2-5-9 Nitrous Oxide Emissions from Fertilized Soil

Emissions Factor (10kg-N/t-N Fertilizer Amount)	Domestic Demand for Nitrogenous Fertilizer (10^3t-N)	Emissions (Gg-N2O)
0.27 (0.06 -- 0.55)	942	4.0

The emissions factor in parentheses represents the range of reported values.

(2) Agricultural Waste Burning

As with methane, this inventory concentrates exclusively on nitrous oxide emissions generated by the burning of rice straw (associated with wetland rice cultivation), rice chaff, and straw from wheat, barley, oats, and rye.

The emissions factors consist of values obtained by the experiment in which straw and chaff were actually burned[(3)].

The activity data consist of the amount of burned material, calculated in the same way as for methane.

Based on the above, total nitrous oxide emissions from agricultural waste burning amounted to 0.7 Gg in fiscal 1990, broken down by type of burned material as shown in Table 2-5-10 below.

Table 2-5-10 Nitrous Oxide Emissions from Agricultural Waste Burning

Material Type		Emissions Factor (g-N2O/kg)	Amount Burned (103t)	Emissions (Gg-N2O)
Wetland Rice	Straw	1.29	438	0.57
	Chaff	0.05	710	0.04
Wheat, Barley, Oats, and Rye	Straw	1.29	54	0.07
Total		------	------	0.7

5-2-4. Waste (Incineration)

Nitrous oxide emissions from incinerated waste are calculated according to two waste categories: municipal and industrial.

Municipal Waste

The nitrous oxide emissions factors for incinerated municipal waste consist of the averages of actual measurements taken at different types of incinerating facilities (continuous, semi-continuous, and batch type)[(1)].

The activity data are the same as those used to calculate methane emissions, consisting of the amounts of waste incinerated at each type of facility.

Based on the above, total nitrous oxide emissions from incinerated municipal waste amounted to 5.0 Gg in fiscal 1990, broken down by type of incinerating facility as shown in Table 2-5-11 below.

Table 2-5-11 Nitrous Oxide Emissions from Incinerated Municipal Waste

Facility Type	Amount Incinerated (104t)	Emissions Factor (g-N2O/t)	Emissions (Gg-N2O)
Continuous	2,693	144 (28.7 -- 293)	3.88
Semi-continuous	296	128 (97.4 -- 145)	0.38
Batch	678	115 (58.5 -- 187)	0.78
Total	------	------	5

Industrial Waste

As with methane, the emissions factor for nitrous oxide was calculated by averaging the emissions factors given for semi-continuous and batch-type incinerators as they appear in the municipal waste category.

The activity data are the same as those used to calculate methane emissions, consisting of the proportion of total processed industrial waste that is incinerated.

Based on the above, total nitrous oxide emissions from incinerated industrial waste amounted to 0.9 Gg in fiscal 1990, broken down by waste type as shown in Table 2-5-12.

Table 2-5-12 Nitrous Oxide Emissions from Industrial Waste Incineration

Waste Type	Emissions Factor (g-N2O/t)	Amount Incinerated (103t)	Emissions (Gg-N2O)
Waste Paper	122 (For All Waste Types)	104	0.01
Wood Waste		899	0.11
Sludge		4,840	0.59
Waste Oil		984	0.12
Waste Plastics		753	0.09
Total	------	------	0.92

(Reference Sources)

5-2-1. Energy (Fuel Combustion)

1) Environment Agency: "Survey on Calculating Emissions Factors for Greenhouse Gases from Stationary Sources" (1993)
2) Agency of Natural Resources and Energy: "Comprehensive Energy Statistics (Fiscal 1993 Edition)" (1994)
3) Environment Agency: "Survey Report on the Analyses of Methane and Other Emissions" (1990)
4) Ministry of International Trade and Industry (MITI): "Yearbook of Dynamic Statistics on the Consumption of Oil and Other Fuels"
5) Environment Agency: "Survey Report on Countermeasures for Greenhouse Gas Emissions from Automobiles" (1992)
6) Ministry of Transport: "Transport Energy Handbook, 1992 Edition" (1992)

5-2-2. Industrial Processes

1) Chemical Industry Bulletin: "11,892 Chemical Products"

5-2-3. Agricultural Sector

1) Katsuyuki Minami: Emission of Nitrous Oxide from Agro-ecosystem, JARQ, 21, 22-27 (1987)

2) Ministry of Agriculture, Forestry and Fisheries: "Pocket Handbook of Fertilizers" (1992)

3) National Institute of Agro-Environmental Sciences, Ministry of Agriculture, Forestry and Fisheries: "Emission of Methane and Nitrous Oxide from Agricultural Land," from Global Environmental Research of Japan in fiscal 1992 (1993)

5-2-4. Waste

1) Institute of Public Health, Ministry of Health and Welfare: "Quantitative Study on Greenhouse Gases Emitted from Solid Waste Disposal Facilities," from Global Environmental Research of Japan in fiscal 1992 (1993)

6. Nitrogen Oxides

6-1. Total Nitrogen Oxides Emissions

Nitrogen oxides are produced when fuels and waste are burned. In conformity with the emission sources indicated in the IPCC/OECD Draft Guidelines, nitrogen oxides emissions in this inventory have been calculated for the following categories: 1) Energy (Fuel Combustion); 2) Industrial Processes; and 3) Waste (Incineration).

According to the calculation methods described in section 6-2, total nitrogen oxides emissions amounted to 1,898 Gg in fiscal 1990, broken down by specific source as shown in Table 2-6-1 below.

Table 2-6-1 Nitrogen Oxide Emissions (Fiscal 1990)

Category			Emissions (Gg-NOx)
Energy	Fuel Combustion		1,844
		Energy & Transformation Industries	388
		Industry	393
		Commercial/Institutional	16
		Residential	38
		Transport	1,009
Industrial Processes			1
Waste	Incineration		53
Total Emissions			1,898

6-2. Nitrogen Oxides Emissions by Sector

6-2-1. Energy (Fuel Combustion)

(1) Energy & Transformation Industries

Nitrogen oxides emissions in the Energy & Transformation Industries were calculated for: electric utilities; manufacturers of petroleum and coal products; gas companies; heat suppliers; and in-house electrical generator operators. In-house electrical generator operators include entities other than electric utilities who own boilers, gas turbines, or diesel equipment for the purpose of generating electricity.

The nitrogen oxides emission amounts used here are equivalent to the values stipulated for "soot and smoke emitting facilities" by the Air Pollution Control Law. Emissions totaled 388 Gg in fiscal 1990[(1)], as shown in Table 2-6-2. Emissions from electric utilities and in-house power generating facilities are not distributed in terms of the electricity demand of users.

(2) Industry

The Industry includes agriculture, forestry, fisheries, mining, construction, and storage industries in addition to manufacturing industries. The nitrogen oxides emission amounts used here are equivalent to the values stipulated for "soot and smoke emitting facilities" by the Air Pollution Control Law. Emissions totaled 393 Gg in fiscal 1990[(1)], as shown in Table 2-6-2.

(3) Commercial/Institutional

Nitrogen oxides emissions in the Commercial/Institutional sector were calculated for: office buildings (heating and cooling systems); inns and restaurants; medical treatment, education and research institutions; public baths; and "other facilities" such as small boilers. The nitrogen oxides emission amounts used here for all sources except the "other facilities" category are equivalent to the values stipulated for "soot and smoke emitting facilities" by the Air Pollution Control Law(1). Emissions from "other facilities" are calculated using various emissions factors(1) according to application and fuel type, and various estimates of fuel consumption(1) according to application.

Based on the above, nitrogen oxides emissions from the commercial sector amounted to 16 Gg in fiscal 1990, as shown in Table 2-6-2.

(4) Residential

Because the small boilers used in the Residential sector do not qualify as "soot and smoke emitting facilities," their nitrogen oxides emissions were calculated using

various emissions factors[1] according to application and fuel type, and various estimates of fuel consumption[1] according to application. Nitrogen oxides emissions from the Residential sector amounted to 38 Gg in fiscal 1990, as shown in Table 2-6-2.

Table 2-6-2 Nitrogen Oxides Emissions from the Energy & Transformation Industry, Industry, Commercial, and Residential Sectors

Sector	Amount of Fuel Consumed (1010 kcal)	Emissions (Gg-NOx)
Energy & Transformation Industry	172,278	388
Industry	84,158	393
Commercial	10,212	16
Residential	24,403	38
Total	291,051	835

(5) Transport

Nitrogen oxides emissions from railroads are excluded from the Transport sector because the majority of trains in Japan run on electricity. The sector is therefore limited to motor vehicles, aircraft (domestic flights) and ships (domestic routes).

Nitrogen oxides emissions from motor vehicles were calculated using weighted-average emissions factors[2] based on actual measurements of emissions from different types of vehicles and engines; these were then multiplied by the number of vehicle-kilometers run by each type of vehicle[3].

Based on the above, nitrogen oxides emissions from motor vehicles amounted to 650 Gg in fiscal 1990, broken down by vehicle type as shown in Table 2-6-3.

Nitrogen oxide emissions from ships (domestic routes) and aircraft (domestic flights) were calculated using the emissions factors provided in the IPCC/OECD Draft Guidelines, multiplied by the amount of fuel consumed[4]. Emissions totaled 359 Gg in fiscal 1990, broken down by transportation type as shown in Table 2-6-4 below.

Table 2-6-3 Nitrogen Oxides Emissions from Motor Vehicles

Vehicle Type	Emissions Factor (g-NOx/vehicle-kilometers)	Vehicle-kilometers Run (1 million vehicle-kilometers)	Emissions (Gg-NOx)
Passenger Cars	0.37	365,598	135
Trucks (Including Buses)	1.96	262,984	515
Total	---	---	650

Table 2-6-4 Nitrogen Oxides Emissions from Ships (Domestic Routes) and Aircraft (Domestic Flights)

Transportation Type	Emissions Factor (g/10^6J)	Amount of Fuel Consumed (10^10 kl)	Emissions (Gg-NOx)
Ships	2.1	3,625	319
Aircraft	0.29	3,254	40
Total	---	---	359

6-2-2. Industrial Processes

Only nitrogen oxides emissions from nitric-acid manufacturing facilities were calculated. Emission amounts are equivalent to the nitrogen oxides values stipulated for "soot and smoke emitting facilities" by the Air Pollution Control Law.

Based on the above, nitrogen oxides emissions from Industrial Processes amounted to 0.8 Gg in fiscal 1990, as shown in Table 2-6-5.

Table 2-6-5 Nitrogen Oxides Emissions from Industrial Processes

Process Type	Amount Produced (10^3t/year)	Emissions
Manufacture of Nitric Acid	705.6	0.8

6-2-3. Waste

Nitrogen oxides emissions from incinerated waste are calculated according to two waste incinerator categories: municipal and industrial.

The emission amounts used here are equivalent to the values stipulated for "soot and smoke emitting facilities" by the Air Pollution Control Law[(1)].

Based on the above, nitrogen oxides emissions from Waste amounted to 53 Gg in fiscal 1990, broken down by type of facility as shown in Table 2-6-6 below.

Table 2-6-6 Nitrogen Oxides Emissions from Waste

Facility Type	Emissions (Gg-NOx)
Municipal-waste Incinerators	44
Industrial-waste Incinerators	9
Total	53

(Reference Sources)

1) Study conducted by the Environment Agency
2) Environment Agency: "Concerning Unit Requirements for Exhaust Gas from Motor Vehicles in Actual Running Mode" (1994)
3) Ministry of Transport: "1991 Statistical Handbook for Land Transport" (1992)
4) Agency of Natural Resources and Energy: "Comprehensive Energy Statistics (Fiscal 1993 Edition)" (1994)

7. Carbon Monoxide

7-1. Total Carbon Monoxide Emissions

Carbon monoxide is produced when fuels and waste are burned. In conformity with the emissions sources indicated in the IPCC/OECD Draft Guidelines, carbon monoxide emissions in this

inventory have been calculated for the following categories: 1) Energy (Fuel Combustion); and 2) Waste (Incineration).

According to the calculation methods described in section 7-2, total carbon monoxide emissions amounted to 2,809 Gg in fiscal 1990, broken down by specific source as shown in Table 2-7-1 below.

Table 2-7-1 Carbon Monoxide Emissions (Fiscal 1990)

Category			Emissions (Gg-CO)
Energy	Fuel Combustion		2,792
		Energy & Transformation Industries	126
		Industry	306
		Commercial/Institutional	5
		Residential	25
		Transport	2,330
Waste	Incineration		17
Total Emissions			2,809

7-2. Carbon Monoxide Emissions by Sector

7-2-1. Energy (Fuel Combustion)

(1) Energy & Transformation Industries

The Energy & Transformation Industries are defined here in the same way as for nitrogen oxides, and includes: electric utilities; manufacturers of petroleum and coal products; gas companies; heat suppliers; and in-house electrical generator operators.

The carbon monoxide emission amounts were calculated by multiplying the amount of fuel consumed[(1)] by an emissions factor based on the simple average of different types of furnaces and fuels used in "soot and smoke emitting facilities" as defined by the Air Pollution Control Law[(1)]. Emissions totaled 126 Gg in fiscal 1990, as shown in Table 2-7-2. Emissions from electric utilities and in-house power generating facilities are not distributed in terms of the electricity demand of users.

(2) Industry

The industry is defined here in the same way as for nitrogen oxides, and includes: agriculture, forestry, fisheries, mining, construction, and storage industries in addition to manufacturing industries.

The carbon monoxide emission amounts were calculated by multiplying the amount of fuel consumed[(1)] by an emissions factor based on the simple average of different types of furnaces and fuels used in "soot and smoke emitting facilities" as defined by the Air Pollution Control Law1). Emissions totaled 306 Gg in fiscal 1990, as shown in Table 2-7-2.

(3) Commercial/Institutional

The Commercial/Institutional sector is defined here in the same way as for nitrogen oxides, and includes: office buildings (heating and cooling systems); inns and restaurants; medical treatment, education and research institutions; public baths; and "other facilities" such as small boilers. The nitrogen oxides emission amounts from all sources except the "other facilities" category were calculated by multiplying the amount of fuel consumed[(1)] by an emissions factor based on the simple average of different types of furnaces and fuels used in "soot and smoke emitting facilities" as defined by the Air Pollution Control Law[(1)].

Emissions from "other facilities" are calculated using various emissions factors[(1)] according to application and fuel type, and various estimates of fuel consumption[(1)] according to application.

Based on the above, carbon monoxide emissions from the Commercial sector amounted to 5 Gg in fiscal 1990, as shown in Table 2-7-2.

(4) Residential

Because the small boilers used in the Residential sector do not qualify as "soot and smoke emitting facilities," their nitrogen oxides emissions were calculated using various emissions factors[(1)] according to application and fuel type, and various estimates of fuel consumption[(1)] according to application. Carbon monoxide emissions from the Commercial sector amounted to 25 Gg in fiscal 1990, as shown in Table 2-7-2.

Table 2-7-2 Carbon Monoxide Emissions from the Energy & Transformation Industries, Industry, Commercial, and Residential Sectors

Sector	Amount of Fuel Consumed (1010 kcal)	Emissions (Gg-CO)
Energy & Transformation Industries	172,278	126
Industry	84,158	306
Commercial/Institutional	10,212	5
Residential	24,403	25
Total	291,051	462

(5) Transport

The Transport sector is defined here in the same way as for nitrogen oxides, and includes: motor vehicles, aircraft (domestic flights) and ships (domestic routes).

Carbon monoxide emissions from motor vehicles were calculated using weighted-average emissions factors[(2)] based on actual measurements of emissions from different types of vehicles and engines; these were then multiplied by the number of vehicle-kilometers run by each type of vehicle[(3)].

Based on the above, carbon monoxide emissions from motor vehicles amounted

to 2,324 Gg in fiscal 1990, broken down by vehicle type as shown in Table 2-7-3 below.

Carbon monoxide emissions from ships (domestic routes) and aircraft (domestic flights) were calculated using the emissions factors provided in the IPCC/OECD Draft Guidelines, multiplied by the amount of fuel consumed[4]. Emissions amounted to 6 Gg in fiscal 1990, broken down by transportation type as shown in Table 2-7-4 below.

Table 2-7-3 Carbon Monoxide Emissions from Motor Vehicles

Vehicle Type	Emissions Factor (g-CO/vehicle-kilometers)	Vehicle-kilometers Run (1 million vehicle-kilometers)	Emissions (Gg-CO)
Passenger Cars	2.09	365,598	763
Trucks (Including Buses)	5.94	262,984	1,561
Total	---	---	2,324

Table 2-7-4 Carbon Monoxide Emissions from Ships (Domestic Routes) and Aircraft (Domestic Flights)

Transportation Type	Emissions Factor (g/106J)	Amount of Fuel Consumed (1010 kl)	Emissions (Gg-CO)
Ships	0.046	3,625	2
Aircraft	0.12	3,254	4
Total	---	---	6

7-2-2. Waste

Carbon monoxide emissions were calculated for waste burned at municipal-waste and industrial-waste incinerators.

Emission amounts were calculated by multiplying the following: emissions factors[1] based on simple averaged values obtained for different types of furnaces and fuels[1]; and heat consumption values[1] calculated by multiplying the amounts of trash and supplementary fuel used by their higher heating values.

Based on the above, carbon monoxide emissions from waste incineration amounted to 17 Gg in fiscal 1990, broken down by type of facility as shown in Table 2-7-5.

Table 2-7-5 Carbon Monoxide Emissions from Waste

Facility Type	Emissions Factor (kg/108 kcal)	Heat Consumption (1010 kcal)	Emissions (Gg-CO)
Municipal-waste Incinerators	14.2	7,557	11
Industrial-waste Incinerators	16.3	3,625	6
Total	---	---	17

(Reference Sources)

1) Study conducted by the Environment Agency
2) Environment Agency: "Concerning Unit Requirements for Exhaust Gas from Motor Vehicles in Actual Running Mode" (1994)
3) Ministry of Transport: "1991 Statistical Handbook for Land Transport" (1992)
4) Agency of Natural Resources and Energy: "Comprehensive Energy Statistics (Fiscal 1993 Edition)"

(1994)

8. Non-methane Volatile Organic Compounds (NMVOCs)

8-1. Total NMVOC Emissions

NMVOCs are produced through the burning of fuels and waste and through the use of organic solvents, etc. In conformity with the emissions sources indicated in the IPCC/OECD Draft Guidelines, NMVOC emissions in this inventory have been calculated for the following categories: 1) Energy (Fuel Combustion and Evaporation during the Handling of Oil, etc.);
2) Industrial Processes; and 3) Solvent Use (Painting and Printing, etc.).

The basic data for determining NMVOC emissions from fixed sources were taken from a survey conducted in 1983, and used to make the best possible estimates for fiscal 1990. It is therefore possible that the resulting values will be revised as more complete information becomes available.

According to the calculation methods described in section 8-2, total NMVOC emissions amounted to about 2,060 Gg in fiscal 1990, broken down by specific source as shown in Table 2-8-1 below.

Table 2-8-1 NMVOC Emissions (Fiscal 1990)

Category			Emissions (Gg-NMVOC)
Energy	Fuel Combustion		340
		Energy & Transformation Industries	40
		Industry	20
		Transport	280
	Evaporation When Handling Oil, etc.		220
Industrial Processes			60
Solvent Use			1,440
Total Emissions			2,060

8-2. NMVOC Emissions by Sector

8-2-1. Energy (Fuel Combustion)

NMVOC emissions are calculated for the Energy & Transformation Industries, Industry, and Transport.

(1) Energy & Transformation Industries

The Energy & Transformation Industries is defined here in the same way as for nitrogen oxides, and includes: electric utilities; manufacturers of petroleum and coal products; gas companies; heat suppliers; and in-house electrical generator operators.

The NMVOC emission amounts were calculated using a hydrocarbon emissions factor based on the simple average of different types of furnaces and fuels used in "soot and smoke emitting facilities" as defined by the Air Pollution Control Law[(1)], multiplied by the proportion of NMVOCs emissions from these facilities[(2)]. The

results were then multiplied by the amount of fuel consumed by "soot and smoke emitting facilities" to obtain the NMVOC emissions for fiscal 1990, which totaled approximately 40 Gg. Emissions from electric utilities and in-house power generating facilities are not distributed in terms of the electricity demand of users.

(2) Industry

The Industry is defined here in the same way as for nitrogen oxides, and includes: agriculture, forestry, fisheries, mining, construction, and storage industries in addition to manufacturing industries.

The NMVOC emission amounts were calculated using a hydrocarbon emissions factor based on the simple average of different types of furnaces and fuels used in "soot and smoke emitting facilities" as defined by the Air Pollution Control Law[(1)], multiplied by the proportion of NMVOCs emissions from these facilities[(2)]. The results were then multiplied by the amount of fuel consumed by "soot and smoke emitting facilities" to obtain the NMVOC emissions for fiscal 1990[(2)], which totaled approximately 20 Gg.

(3) Transport

NMVOC emissions in the Transport were calculated for motor vehicles and aircraft (domestic flights).

NMVOC emissions from motor vehicles were calculated using a weighted-average hydrocarbon emissions factor[(3)] based on actual measurements of emissions from different types of vehicles and engines, multiplied by the proportion of NMVOCs emissions from motor vehicles. In this case, the proportion of NMVOCs to total hydrocarbon emissions[(2)] was set at 60% for gasoline-run vehicles and 99% for diesel-run vehicles. The results were then multiplied by the number of vehicle-kilometers run by each type of vehicle[(4)].

According to the above calculations, NMVOC emissions from motor vehicles totaled approximately 280 Gg in fiscal 1990.

NMVOC emissions from aircraft (domestic flights) were calculated using the emissions factors provided in the IPCC/OECD Draft Guidelines, multiplied by the amount of fuel consumed[(5)]. Emissions totaled approximately 2 Gg in fiscal 1990.

8-2-2. Energy (Evaporation When Handling Oil, Etc.)

NMVOCs evaporate when crude oil, gasoline, naphtha, and jet fuel are handled. Emissions factors used here apply to oil refineries, storage tanks, shipping facilities, and filling stations[(6)].

The activity data for refineries consist of barrels per served day processed by

topping plants[7]; those for storage tanks consist of the amounts of fuel poured into or taken out of tanks of different types and sizes[8]. Those for shipping facilities[7] and filling stations[8] consist of the amounts of fuel handled.

Based on the above, total NMVOC emissions in fiscal 1990 from evaporation when handling oil, etc. amounted to approximately 220 Gg, most of which were emitted from storage tanks, shipping facilities and filling stations.

8-2-3. Industrial Processes

Calculations were made of NMVOC emissions from the manufacturing processes of the following products: lubricating oil, basic petrochemical products, carbon black, paints, and printing inks.

The emissions factors are based on values obtained through surveys conducted for each manufacturing process[8]. The activity data for lubricating oil, basic petrochemical products, and carbon black consist of the production amounts of each substance[7]; those for paints and printing inks consist of the amounts of each type of solvent used as raw material[9].

Based on the above, total NMVOC emissions from Industrial Processes amounted to approximately 60 Gg in fiscal 1990.

8-2-4. Solvent Use

NMVOC emissions from solvent use were calculated for the following products and processes: paints; printing; rubber; adhesives; surface finishing of metals and other materials; dry cleaning; and other solvent applications.

The emissions factors for solvent use associated with paints, printing, rubber, and adhesives are based on values obtained through surveys conducted for each product or process[8]. The activity data for paint consist of the amounts of different kinds of paint consumed[9]; for printing, the amounts of different kinds of printing inks consumed[9]; for rubber, the amount of gasoline consumed as a solvent for different types of rubber products[9]; and for adhesives, the amounts of different types of adhesives consumed[9].

Emissions associated with the surface finishing of metals and other materials, dry cleaning, and other solvent applications were estimated on the basis of surveys[8].

Based on the above, total NMVOC emissions from the solvent use amounted to approximately 1,440 Gg in fiscal 1990.

(Reference Sources)

1) Study conducted by the Environment Agency
2) Study conducted by the Environment Agency
3) Environment Agency: "Concerning Unit Requirements for Exhaust Gas from Motor Vehicles in Actual

Running Mode" (1994)

4) Ministry of Transport: "1991 Statistical Handbook for Land Transport" (1992)

5) Agency of Natural Resources and Energy: "Comprehensive Energy Statistics (Fiscal 1993 Edition)" (1994)

6) Study conducted by the Environment Agency

7) Ministry of International Trade and Industry (MITI): "Statistical Yearbook on 1990 Energy Supply and Demand" (1991)

8) Study conducted by the Environment Agency

9) MITI: "1992 Statistical Yearbook on the Chemical Industry" (1993)

Chapter 3 (Part I)

Outline of Policies and Measures

(Countermeasures Against Global Warming)

1. Conclusion of the United Nations Framework Convention on Climate Change

The United Nations Framework Convention on Climate Change (hereinafter "the Convention") was adopted at the Second Part of the Fifth Session of the Intergovernmental Negotiating Committee (INC) for a Framework Convention on Climate Change held in May 1992. In the following month, the convention was opened for signature at the United Nations Conference on Environment and Development (UNCED). While UNCED was in session, the Convention received 155 signatures. Japan, too, signed the Convention on June 13, when UNCED was in session.

The government thereafter deposited the instrument of acceptance with the Secretary-General of the United Nations on May 28, 1993. Japan was the 21st party to the Convention and thus contributed to its entry into force.

Furthermore at the Eighth INC held in August 1993, Japan sought to take measures in accordance with the decision "to invite states... to communicate as soon as feasible... information regarding measures consistent with the provisions of the Convention pending its entry into force " adopted at the Second Part of the Fifth Session of INC and 47th UN General Assembly. As part of this measure, Japan compiled and submitted "JAPAN'S RESPONSE TO GLOBAL WARMING" with the aim of introducing the status of Japan's measures to cope with global warming.

2. Formulation and Promotion of the Action Program To Arrest Global Warming

The Japanese government established the Council of Ministers for Global Environment Conservation on May 12, 1989 in order to secure close ties with the concerned government organizations and comprehensively and effectively promote such ties. These efforts aimed at coping with environmental problems which produce serious effects on a global scale. In June the same year, the Council reached an agreement on "measures for the preservation of the global environment," which indicated the basic direction of measures to be taken by Japan in the near term. Then in October, the Council came to an agreement on the "comprehensive promotion of research, observation/monitoring, and technological development for the conservation of the global environment." In June 1990, it decided to undertake the "Comprehensive Promotion Program for Global Environment Research, Monitoring and Technology Development for Fiscal 1990," and internationally advocated the necessity of drawing up at nearly date an action program to arrest global warming and crystallizing a long-term vision to meet global warming (New Earth 21). Prompted by this decision, the Council finalized the Action Program To Arrest Global Warming in October the same year. The objective of the Action Program is to clarify the government's near-term policies for promoting systematic and comprehensive measures to deal with global warming, as well as the whole picture of feasible measures to be undertaken in the future. At the same time, this program aims to gain the understanding and cooperation of the people and define Japan's basic position on making a contribution to the formation of an international framework dealing with global warming. Moreover, the Action Program is the national program of Japan provided for in Article 4 paragraph 1 (b) of the Convention.

The Action Program prescribes that it is the obligation of our generation to hand over a sound global

environment to future generations. Further, the Program clearly discusses the basic recognition that it is essential for each nation of the world to coordinate with one another and to steadily promote feasible measures. It cites the formation of an environmentally-sound society, compatibility with the stable development of the economy, and international coordination as issues that should be considered for the promotion of measures to cope with global warming.

The Action Program sets the year 2000 as the intermediate target year and covers until 2010. It also sets forth the following targets to reduce greenhouse gas emissions.

(1) The Government of Japan, based on the common efforts of the major industrialized countries to limit CO_2 emissions, establishes the following target for the stabilization of Japan's CO_2 emissions.

a. The emissions of CO_2 should be stabilized on a per capita basis in the year 2000 and beyond at about the same level as in 1990, by steadily implementing a wide range of measures under this Action Program, as they become feasible, through the utmost efforts by both the government and private sectors.

b. Efforts should also be made, along with the measures above, to stabilize the total amount of CO_2 emission in the year 2000 and beyond at about the same level as in 1990, through progress in the development of innovative technologies, etc., including those related to solar, hydrogen and other new energies as well as fixation of CO_2 at the pace and in the scale greater than currently predicted.

(2) The emission of methane gas should not exceed the present level. To the extent possible, nitrous oxide and other greenhouse gases should not be increased.

With respect to sinks of CO_2, efforts should be made to work for the conservation and development of forests, greenery in urban areas and so forth in Japan and also to take steps to conserve and expand forests on a global scale, among others.

The Action Program also calls for the implementation of the following necessary measures: measures to limit CO_2 emissions, measures to reduce the emission of methane and other greenhouse gases, measures to enhance CO_2 sinks, the promotion of research and observation/monitoring, the development and dissemination of technology, the promotion of public awareness, and the promotion of international cooperation.

Under the framework for promoting this Action Program, the progress of implementation and other issues described in the Program are followed up each year at the the Council of Ministers for Global Environment Conservation. Based on this follow-up, the promotion of the Action Program is reexamined. In the past, the status of implementation of measures and the total emission of CO_2 were reported on May 23, 1992 and June 23, 1993.

Also, in promoting this Action Program, local governments are solicited for their cooperation, and information and basic directions are presented for efforts by local governments to cope with global warming. In addition, support is provided to local governments by helping them consolidate conditions for the implementation of their measures. In connection with this, guidelines are established for the formulation of a plan to promote regional efforts to cope with global warming from the standpoint of advancing systematic countermeasures against global warming in local communities. At the same time, financial assistance is extended to defray the expenses required for the formulation of this plan. Today, of 59 groups in prefectures and cities designated by the government ordinance throughout Japan, more than 70% of them are mapping out policies and plans concerning global environmental problems stemming from global warming and are forming organizations to promote these efforts. Under this system, assistance and guidance are provided to efforts by residents and corporations; cities and local communities that contribute to the conservation of the global environment are being developed; research and observation/monitoring are being carried out; bureaucrats are taking the initiative and carrying out exemplary activities; international environmental cooperation are being carried out; and other measures and projects are being implemented.

The Council of Ministers for Global Environment Conservation decided to internationally advocate the necessity of formulating a long-term vision (New Earth 21) to deal with global warming. This vision calls for, among other things, (1) the promotion of worldwide energy conservation, (2) the broad introduction of clean energy, (3) the development of innovative environmental technology, (4) the expansion of sinks of CO2, and (5) the development of innovative energy-related technology for the next generation. This effort aims to regenerate the earth, which has undergone change for 200 years since the Industrial Revolution, over the next several decades. The Council is touting New Earth 21 to the international community as a program that endeavors to promote long-term, comprehensive activities to limit and reduce the emission of greenhouse gases through the cooperation of all countries in the world.

The objective of New Earth 21 is to reduce by the year 2100 the balance of emission of all greenhouse gases, in terms of CO2-equivalents, by 60% of the current level and by roughly 85% compared with the high emission scenario of IPCC.

Concept of New Earth 21

(1) Total emission of greenhouse gases

(2) Global climate change

- Global temperature rise
  (an increase of about 3 C from the current level)
- Rise in sea level
  (a rise of about 65cm from the current level)

(3) Promotion of energy conservation worldwide
Technology transfer
Substantial introduction of clean energies

(4) Development of innovative environment technology
Expansion of sinks of CO_2
Development of innovative energy-related technology for the next generation
Technology development

(5) In the case of nature (doubling of concentration of greenhouse gases in the year 2030)

(6) In the case of New Earth 21

(7) Regeneration of greenery

3. Enactment of the Basic Environment Law

Until now, Japan's environmental policies have been based on the Basic Law for Environmental Pollution Control, which was enacted in 1967, and the Nature Conservation Law, which was enacted in 1972.

In recent years, however, global warming and other global environmental problems, as well as environmental problems concerning waste, have been spotlighted as fresh environmental issues against the backdrop of an expansion in socioeconomic activities.

These new environmental problems are characterized by spatial extension throughout the world and the spreading of their effects through time to future generations. Furthermore as can be seen from the role that forests play in preventing global warming and the impact of acid rain on the natural ecosystem, it is vital to get a grasp of the overall picture of the environment itself.

At the time the Basic Law for Environmental Pollution Control and the Nature Conservation Law were enacted, principal environmental problems consisted of severe pollution stemming from large-scale pollution sources, as well as other problems arising from specific activities of specific sources. As opposed to this, today's primary environmental problems include global warming and air pollution caused by NOx in large cities. The root cause of all these problems lies in the load on the environment originating from everyday lives of the public and ordinary business undertakings by companies. The conventional system of obligations and measures stipulated by the Basic Law for Environmental Pollution Control and the Nature Conservation Law centered on regulations on companies and enterprises and other measures. But due to the aforesaid changes, this system can no longer adequately deal with today's environmental problems. It has now become necessary to take steps to make a transition to a system that widely takes into account the lifestyles and business activities of the public and companies in examining the environment.

Also, owing to the increasing visibility of global environmental problems such as global warming,

domestic measures alone cannot completely conserve the environment. Thus, it is crucially important to undertake joint efforts with other countries including treaties and conventions, international cooperation, and other international measures.

In particular, global warming has the following salient features: (1) Although it may have far-reaching effects in the future, it is an irreversible phenomenon that hardly returns to the normal state even if measures are taken after the effects manifest themselves. Thus it is essential to implement measures to immediately forestall these effects while upgrading scientific knowhow; (2) A wide range of measures should be taken to deal with various activities that emit CO_2 and other gases. Through these measures, the whole society must change to one with a small load on the environment; (3) It is vital to aggressively undertake measures under international cooperation.

Against this background, a new basic law for the conservation of the environment was enacted in November 1993. This law (1) takes into consideration future generations and the whole world, (2) attempts to preserve the environment by taking into account effects that will arise for the first time in future generations and effects on the ecosystem, (3) clearly defines the independent and active role that all members of the society play in conserving the environment under a fair burden-sharing scheme, (4) clearly envisions the development of a society with a small load on the environment by combining various methods in addition to regulations, and (5) accurately defines not only domestic measures but also international efforts.

As such, the Basic Environment Law was enacted with the aim of building a framework that could adequately cope with global warming and other global environmental problems. The enactment of the Basic Environment Law (hereinafter "the Law") is of great significance for advancing measures to prevent global warming in Japan.

First, for instance, the Law proposes three new basic principles for conservation of the environment. That is to say, these principles stipulate that: (1) Environmental conservation shall be conducted appropriately to ensure that the present and future generations of human beings can enjoy the blessings of a healthy and productive environment and that the environment as the foundation of human survival can be preserved into the future; (2) Environmental conservation shall be promoted so that a society can be formulated where the healthy and productive environment is conserved and sustainable development is ensured by fostering sound economic development with reduced environmental load; and so that interference with environmental conservation can be anticipatively prevented through enhancing scientific knowledge; (3) Global environmental conservation shall be actively promoted in cooperation with other countries, utilizing Japan's capacities and resources, and in accordance with Japan's standing in the international community.

Second, the Law prescribes that the government shall establish a basic plan with regard to the environmental conservation (the Basic Environment Plan) as the centerpiece of its environmental policies. In consideration of the importance of countermeasures against global warming, the Action Program To Arrest Global Warming already a government policy will be appropriately incorporated into this basic plan.

Third, the Law prescribes a variety of measures to be taken by the government, in addition to the regulations set forth in the Basic Law for Environmental Pollution Control. These measures comprise environmental impact assessment; economic measures; promotion of construction of facilities and other

projects for environmental conservation; promotion of use of products contributing to reduction of environmental load; education on the environment; promotion of voluntary activities by the private sector; promotion of science and technology; and international cooperation for global environmental conservation.

With respect to economic measures in addition to the conventional subsidiary measures, the Law deals with measures that impose appropriate and equitable economic surcharges on those who conduct the load activities. It stipulates that surveys and researches should appropriately be conducted on the effectiveness of implementing such measures with regard to prevention of interference with environmental conservation and on the effects of such measures on the Japanese economy. It also stipulates that, in case such measures have to be implemented with, efforts should be made to acquire the understanding and cooperation of the people regarding utilization of such measures to prevent interference with environmental conservation, and that international collaboration should be considered so as to appropriately ensure the effectiveness of such measures.

Fourth, it can be pointed out that provisions were established for international cooperation for global environmental conservation. Based on this, measures will be taken to promote international cooperation in contributing to the development of an international framework and to the transfer of technology to developing countries. Thus, in the future, measures will be taken to prevent global warming as well, based on the Basic Environment Law.

Chapter 3 (Part II)

Policies and Measures in Detail

1. Measures to Limit Carbon Dioxide Emissions

1-1. The Industrial Sector (Energy, Non-Energy, and Agriculture)

<The Approach of Policies and Measures>

The industrial sector accounted for 46.2% of total carbon dioxide (CO_2) emissions in fiscal 1990. This figure breaks down to: direct combustion 28.5%, power generation 13.2%,
(energy-related total of 41.7%), and industrial decomposition of limestone 4.5%.

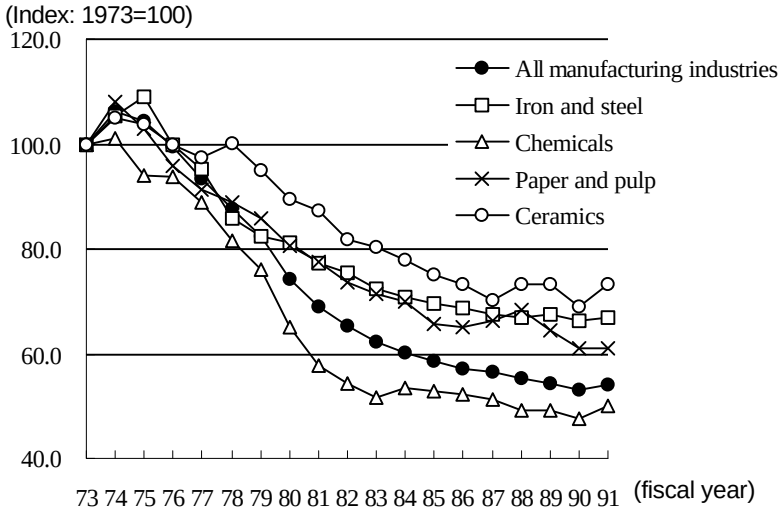
Mining and manufacturing industries account for the majority of energy consumption in the industrial sector. The main measures taken in these industries after the two oil crises in 1973 and 1978 are as follows:

First, measures based on the Law Concerning the Rational Use of Energy (enacted in 1979; hereinafter referred to as the Energy Conservation Law); e.g., the establishment and administration of standards.

Second, support of investment in energy-saving plant and equipment through low-interest loans and special taxation measures.

Third, development of technology that contributes to energy conservation.

Figure1-1-1 Changes in Unit Energy Consumption in the Industrial Sector



Note: The index for mining and manufacturing production is on a value-added basis (values corrected for energy balance)

Resources: Comprehensive Energy Statistics, Annul Report of Mining and Manufacturing Production

Under these policies, factories and places of business have actively pursued efficient energy use, and energy consumption per unit production in the mining and manufacturing industries has shown marked improvement as a result. Those investments with the greatest energy-saving impact have now been completed.

In order to achieve further energy savings, industrial energy policy was drastically

strengthened in 1993 by revision of the Energy Conservation Law and enactment of the Law on Temporary Measures to Promote Business Activities for the Rational Use of Energy and the Utilization of Recycled Resources (hereinafter referred to as the Energy Conservation and Recycling Assistance Law).

Other efforts include energy conservation measures in agriculture, forestry, fisheries, and the construction industry, development of CO_2 fixation and other non-energy-related technology, and requests to the private sector to draw up Voluntary Plans Concerning Environment.

<Policies and Measures in Detail>

1-1-1. Rational Energy Use in Factories and Places of Business

(1) Measures based on the Energy Conservation Law, including the establishment and administration of standards

[1] Prior to the 1993 revision

- Issuance of standards

  Based on the Energy Conservation Law, in 1979 the Minister of International Trade and Industry issued standards for items that included rationalization of fuel combustion and heating, prevention of heat loss, and recovery and utilization of waste heat.

- Guarantees for the standards

  If a designated energy-management facility(*) was deemed to have made extremely unsatisfactory progress toward rational energy use in comparison with the standards, the pre-revision Energy Conservation Law empowered the competent Ministers (the Minister of International Trade and Industry and the minister with jurisdiction over the particular business) to issue a recommendation for improvement and direct the operator to submit and implement a rationalization plan.

  (*) A factory or place of business with annual fuel consumption equivalent to at least 3,000 kl of crude oil or annual electricity consumption of at least 1,200 kW, designated by the Minister of International Trade and Industry.

  As of March 31, 1993, a total of 2,205 plants had been designated with regard to heat use and 2,637 plants with regard to electricity use. The system covers about 70% of energy consumption in the industrial sector.

- Other measures

  Designated energy-management facilities were required by the 1979Energy Conservation Law to hire a certified energy manager, keep

records of their energy consumption status, etc.

[2] Strengthening of measures in the 1993 revision

- Revision and strengthening of the standards Target: 1% annual average improvement in unit energy consumption

  The revision of the Energy Conservation Law was accompanied by a complete review of the standards in July 1993. Standard and target values were established separately for each item and the standards were expanded and tightened with the aim of reducing domestic unit energy consumption by at least 1% annually as an average for all operators.

- Strengthening of guarantees for the standards

  Under the revised law, which took effect in August 1993, if an operator fails to comply when directed to prepare a rationalization plan, the competent Ministers are authorized to make the case public and issue an order. An operator who fails to obey an order is subject to penalty.

- Mandating of regular reports from designated energy-management facilities

  Where the 1979 Energy Conservation Law required designated energy-management facilities to keep records of their energy consumption status, the revised law requires them to report this status annually to the competent Ministers.

(2) Measures to assist investment in plant and equipment

[1] Special taxation measures (expanded in fiscal 1994)

Special taxation measures were instituted in fiscal 1975 for the installation of plant and equipment that contributes to energy conservation. Specifically, the present system of taxation measures to promote investment for improvement of the energy supply-and-demand structure (hereinafter called taxation measures for energy investment) offers two alternatives:

-- a tax credit, in which a sum equivalent to 7% of the acquisition cost can be deducted from income tax or corporate tax

-- a special depreciation, in which 30% of the acquisition cost can be amortized in addition to ordinary depreciation. New items were added to the list of eligible plant and equipment in fiscal 1994, raising the total number from 225 to 252. (Another 61 items are eligible until September 1994.)

[2] Low-interest loans

A system of low-interest loans, mainly by the Japan Development Bank, was instituted in fiscal 1975 for the installation of plant and equipment that contributes to energy conservation. Eligible items include auxiliary equipment (e.g., for waste heat utilization), energy-saving equipment using such methods as ion-exchange membranes, and cogeneration system equipment.

[3] Strengthening of assistance based on the Energy Conservation and Recycling
Assistance Law

With the enactment of the Energy Conservation and Recycling Assistance Law, specifically, the following measures are provided to assist plant and equipment investment which has received planning approval under this law:

-- loans at very low interest (by means of interest subsidies in addition to the low-interest financing provided mainly by the Japan Development Bank)
-- special taxation measures for systems-based investment
-- guarantees of obligation by the Facilitation Fund for Industrial Structural Adjustment

(3) Promotion of Technological Development

* In fiscal 1993, a Special Account for energy conservation was newly established and budgetary provisions were expanded and improved with particular emphasis on technological development.
Measures included the creation of a subsidy system to promote commercialization of related technology (fiscal 1993 budget allocation: 1,306 million), and development of high-performance industrial furnaces (fiscal 1993 budget allocation: 572 million).

* Other work in progress includes element research on the direct iron ore smelting reduction process and trial operation of a pilot plant (fiscal 1993 budget allocation: 1,850 million), and element research and trial operation of a pilot plant for an entrained-flow coal gasification power plant (fiscal 1993 budget allocation: 3,575 million).

1-1-2. Rational Energy Use in Agriculture, Forestry, Fisheries, and the Construction Industry

* In agriculture and fisheries:

In greenhouse vegetable growing and horticulture, subsidies are provided for the

installation of production systems that harness unused energy (e.g., solar heat, other forms of natural energy, heat from garbage incineration), or that give a high degree of control over energy use. In fiscal 1992, three greenhouse complexes received subsidies.

* Plant and equipment eligible for taxation measures for energy investment include air heating systems utilizing geothermal for greenhouse and wood drier that harnesses solar heat, in fiscal 1992, livestock barns with augmented heat insulation also became eligible.
* In the area of technological development, industrial materials such as bioplastics and bioenergy resources are being developed.
* In the construction industry:
- Plant and equipment eligible for taxation measures for energy investment include mobile equipment for construction work (such as wheel loaders) acquired by small and medium-sized companies. In 1994, road rollers, etc., also became eligible.
- The work specifications of government agencies now permit the use of blast-furnace slag cement.
* Efforts to develop energy-saving technology include studies to determine the state of CO2 emissions in the locality during the construction and use of civil engineering structures and buildings. The findings provide a basis for systematically organizing energy-saving technology and formulating design and implementation standards.

1-1-3. R&D of Technology for Conservation of the Global Environment, and Related Research

* R&D of Technology for Conservation of the Global Environment is being pursued as part of the New Sunshine Program, with an approach based on the circulation mechanism of CO_2. Work in progress includes:
* development of technology for the fixation and efficient utilization of CO_2 by means of bacteria, algae, or Reaction of catalytic hydrogenation, and High-temperature CO_2 Separation Fixation and Utilization Technology.
* studies of technology for environmentally sound production processes, such as research on high-performance Bioreactors for the Production of Biochemicals, Biological Production of Hydrogen by Environmentally Acceptable Technology.
* In addition, the Institute of Physical and Chemical Research and other agencies are pursuing basic research in related fields, e.g., the science of photosynthesis, which converts CO_2 to fuel substances.

1-1-4. Facilitation of Independent Efforts by the Private Sector

Individual companies are making their own efforts to limit CO_2 and other emissions.

These have become part of a broad trend, as seen in the publication by various economic organizations of their policies to address global environmental issues. With this background, in October 1992 eighty-seven major industrial organizations were asked to draft Voluntary Plans Concerning Environment. A model plan was provided for reference; it suggests setting targets for independent efforts on various types of global warming countermeasures. Specifically, it recommends setting concrete targets (such as energy consumption per unit sales) for energy conservation and control of CO_2 emissions, in-house waste reduction and recycling, percentage use of recycled materials, reduction of packaging materials, and reclaiming of company products after use.

1-2. The Residential and Commercial Sector

<The Approach of Policies and Measures>

The residential and commercial sector accounted for 22.3% of total CO_2 emissions in fiscal 1990. This figure breaks down into commercial 10.5%, residential 11.8%; it can also be broken down into power generation 11.6%, direct combustion 10.8%. Overall, the share of total CO_2 emissions accounted for by this sector continues to grow.

Energy consumption in the residential and commercial sector has shown an almost continuous upward trend over recent years, driven by such factors as ongoing office automation and the rising ownership of increasingly large household appliances. To counteract this trend, the following measures have been taken in this sector:

First, measures to achieve greater energy conservation in building structures, including the establishment and administration of standards based on the Energy Conservation Law, support of investment in energy-saving plant and equipment through low-interest loans, and promotion of technological development.

Second, measures to increase the energy efficiency of household appliances and office equipment, etc.; specifically, the establishment and administration of standards based on the Energy Conservation Law, and promotion of technological development.

Third, measures to promote the utilization of unused energy such as waste heat at the district level.

Fourth, measures to alleviate the heat island phenomenon by planting greenery in urban areas, thereby reducing the energy demand for air-conditioning in summer.

Fifth, measures to encourage city planning that reduces the environmental burden imposed by CO_2 emissions and other factors.

For the present, at least, in due consideration of the Japanese people's aspirations toward a comfortable standard of living, concrete policy instruments are not being implemented to limit actual increase in ownership or use of appliances in order to control energy consumption.

<Policies and Measures in Detail>

1-2-1. Energy-efficient Building Design

(1) Housing

[1] Insulation performance standards for housing

Based on the Energy Conservation Law, in 1980 the Minister of International Trade and Industry and the Minister of Construction issued performance standards for housing insulation, and design and execution guidelines based thereon.

In February 1992, the old standards and guidelines were reviewed, and the insulation performance standards and related provisions were strengthened to levels comparable with those of the cold regions of Europe and North America. For example, the standards in Sendai are now similar to those of New York, while Tokyo now has more stringent standards than Paris.

[2] Assistance measures

- Since fiscal 1992, home building or remodeling that meets the above standards has been eligible for additional financing above the ordinary loan ceiling of the Government Housing Loan Corporation. As an incentive for the construction of "environment-harmonized houses," the Government Housing Loan Corporation also offers additional financing (the "environment-harmonized house premium") for building of insulated structures, installation of energy-saving heating, cooling, and hot-water systems, building of solar houses, etc. Further, in fiscal 1992 subsidies were instituted for local public authorities that draft plans relating to "environment-harmonized houses," and related projects were implemented in four municipalities in the initial year. In fiscal 1993, subsidies were introduced for the preparation of planting sites on artificial ground, laying of water-permeable paving, etc., in new model housing complexes.
- To promote the use of solar energy systems, subsidies are granted to local public authorities and public corporations that install such systems in educational, cultural, medical or other facilities, and to private-sector organizations engaged in related educational and informational projects such as making television programs. In addition, low-interest loans are available to those who install a home solar energy system or a solar house system. In fiscal 1993, the budgetary allocation in this area was approximately \1 billion. As of March 1992, there were 4.6 million solar

water heaters and 380,000 solar energy systems in use.

* Since fiscal 1992, subsidies have been awarded to model projects introducing advanced technology for efficient energy use (e.g., waste-heat recovery, insulation) as an integrated system. The budgetary allocation in fiscal 1993 was approximately \480 million.

[3] Promotion of technological development

Studies are being conducted to raise energy self-sufficiency in housing as part of the Housing Development Project for the 21st Century, whose goal is the production of affordable prefabricated housing with individuality and high functionality.

(2) Commercial buildings

[1] Insulation performance standards for commercial buildings Based on the Energy Conservation Law, the Minister of International Trade and Industry and the Minister of Construction have established standards for insulation performance and efficiency of air-conditioning equipment in offices (1980), shops (1985), and hotels and inns (1991).

The revision of the Energy Conservation Law was accompanied in July 1993 by a review of the standards and expansion of their scope to include schools and hospitals. In addition to insulation and air-conditioning equipment, standards were also set for mechanical ventilation, lighting, hot-water supply, and elevator equipment.

[2] Guarantees for the standards

In cases where the provisions for rational energy use in the construction of a building of 2,000 or more square meters are deemed to be extremely unsatisfactory in comparison with the standards, the 1993 revision of the Energy Conservation Law authorizes the Minister of Construction to issue directives to the building owner and to make the case public.

[3] Strengthening of measures to assist investment in plant and equipment

- Taxation measures for energy investment have been put in place for building equipment with high energy efficiency, including heat pumps, floor heating, and thermal-storage air-conditioning and hot-water equipment, and for equipment that utilizes natural energy such as solar heat. (For photovoltaic power generation, see under "The Energy Conversion Sector.")
- The 1993 Energy Conservation and Recycling Assistance Law provided for

the establishment of new forms of assistance, such as guarantees of obligation and interest subsidies, in cases where the builder of a commercial building achieves an overall level of energy conservation that is deemed adequate in comparison with the guidelines for voluntary energy conservation efforts laid down by the competent minister.

Since fiscal 1993, the Japan Development Bank has provided long-term low-interest loans for the total construction costs of buildings that have high energy efficiency and incorporate measures to reduce the environmental burden ("eco-care buildings").

[4] Making government buildings energy-efficient

Based on the 1980 "Guidelines for Energy-efficient Building Design in Government Offices," governmental facilities have been built with a view to energy conservation, and since fiscal 1981 existing facilities have also been improved to achieve energy savings. Seventy-three such projects were carried out in fiscal 1992. Also, in fiscal 1993, items using a solar power-generating system are being placed in post offices on a trial basis, and we are considering the best way to use these items in the future.

- Measures relating to water supply include: the development of energy-saving technology for end-user supply systems enabling direct supply of water in buildings of up to about ten stories.

1-2-2. Increasing Energy Efficiency of Appliances

(1) Measures based on the Energy Conservation Law, including the establishment of standards

[1] Outline of measures based on the Energy Conservation Law

For items designated "specified equipment" by government ordinance, the law presents standards for improvement of energy efficiency to the manufacturer or other operator, and mandates labeling to indicate energy efficiency. The 1993 revision of the law strengthened the guarantees for mandatory labeling. If an operator fails to comply with a directive for appropriate labeling, the revised law empowers the Minister of International Trade and Industry to make the case public and issue an order. An operator who fails to obey an order is subject to penalty.

Also, single-purpose air conditioners (i.e., those not combined with heaters) were originally the only residential or commercial appliances designated as specified equipment, but this scope was broadened considerably by the revisions.

[2] Revision of the standards for air conditioners

Single-purpose air conditioners were designated as specified equipment at the time of the enactment of the Energy Conservation Law, and the Minister of International Trade and Industry issued standards for them in 1980. These standards were reviewed in December 1993, and new standards were established for combined air conditioner and heater units. They call for approximately 5% improvement in energy efficiency over the fiscal 1992 results by the end of September 1998.

[3] Establishment of standards for fluorescent lights

In April 1994, fluorescent lights were designated as specified equipment and standards were established. These call for 3 to 7% improvement in energy efficiency over present levels by fiscal 2000.

[4] Establishment of standards for television sets

Television sets were also designated as specified equipment in April 1994, and standards were established calling for 5 to 25% improvement in energy efficiency over present levels by fiscal 1998.

[5] Establishment of standards for photocopiers

Photocopiers were also designated as specified equipment in April 1994, and standards were established calling for 3% average improvement in energy efficiency over present levels by fiscal 2000.

(2) Promotion of technological development

In fiscal 1993 a system of subsidies was established to promote commercialization of energy-saving technology (budget for the initial fiscal year: \1.306 billion). Among other efforts in this area is the development of non-chlorofluorocarbon coolants with high energy efficiency.

1-2-3. Utilization of Unused Energy Sources at the District Level

* Subsidies are granted to pioneering district heat and cooling (DHC) systems that harness unused energy sources such as urban waste heat or the thermal energy of river water. Works in nine districts and studies in six districts were subsidized in fiscal 1992. A low-interest loan system for DHC facilities is also available, financed largely by the Japan Environment Corporation and the Japan Development Bank; it granted loans to sixteen operators in fiscal 1992. Further measures were established in fiscal 1991 making low-interest loans (mainly from the Japan Development Bank) available on still more favorable terms to meet plant and equipment needs for heating and cooling that utilizes unused energy sources; in fiscal 1993 six operators received loans under this program.

* An interest subsidy program is available for the installation of facilities that utilize heat from waste incineration. The Japan Environment Corporation also provides loans for facilities that effectively utilize waste heat as part of an integrated system in conjunction with industrial waste disposal facilities.
* A subsidy system for "environment-harmonized energy communities" was established in fiscal 1993 to support surplus energy utilization, cascade utilization, etc.
* Taxation measures for energy investment have been instituted for DHC facilities, boilers utilizing waste heat, etc., and in 1993 they were extended to devices for the utilization of urban waste heat such as thermal energy from river water or heat from the incineration of sewage sludge.
* Measures for technological development include:
  - Subsidies for the development of technology such as the element technology of heating plants that utilize unused energy, and the design of high-efficiency heating systems and optimal plant planning and operating systems.
  - A seven-year technology development program, launched in 1991, to introduce and promote DHC systems that harness unused energy, such as urban waste heat and the thermal energy of river water.
  - Basic development work, begun in fiscal 1993, for the building of "eco-energy city systems" which will efficiently recover unused and waste heat from industrial processes by means of coordinated multistage systems, transport it over long distances with low heat loss, and supply the energy to sites of residential and commercial demand.
* In fiscal 1994, a subsidy system is to be established for the construction by local public authorities of facilities to utilize the heat energy of sewage and water from sewage treatment plants.

1-2-4. Alleviating the Heat Island Phenomenon by Promoting Urban Greenery and Other Measures

The heat island phenomenon arises in urban areas because of their concentrated energy consumption, coupled with the loss of the cooling effect of moisture evaporation due to the paving over of ground surfaces, which also causes the sun's heat to be stored and released at night. The result is a vicious circle in which city dwellers turn up their air conditioners and the air temperature rises still higher. The phenomenon is being addressed mainly by increased planting of greenery to take advantage of its functions in regulating air temperature, and by increased use of permeable paving materials and other measures to improve the urban hydrological cycle.

* The Fifth Five-year Program for Developing City Parks, Etc. has been formulated for systematic improvement of urban parks and other green areas, allocating a total of some \5 trillion over a five-year period from fiscal 1991 to 1995. As of March 31, 1990, in areas covered by the program the level of provision of urban parks and green areas stood at approximately 5.8 m^2 per capita of population; this is to be increased to approximately 7.0 m^2 by the end of the Five-year Program. Basic Plan for Public Investment calls for about 10 m^2 per urban resident by the year around 2000. In fiscal 1992, improvements based on the program were made to some 2,500 areas, including 15 large parks under national management, at a cost of \579.7 billion.
* The Ministry of Construction has drawn up a Five-year Program for the Planting of Trees, Etc., which spans the period to fiscal 1997 and applies to urban parks and other green areas, roads, riverbanks, steep slopes, sewage treatment plants, government facilities, public housing, etc., and seeks to promote the planting of greenery and tall trees.
* Other efforts to provide green areas in the cities are being pursued as part of the program of construction and transfer of buffer green areas, green areas for air pollution control, and green areas integrated with industrial waste disposal facilities by the Japan Environment Corporation. Still others are carried out under the Pollution-related Health Damage Compensation and Prevention Association's fund to prevent health damage caused by air pollution. In fiscal 1992, the Corporation prepared nine green areas and the Association carried out planting projects at 22 sites with a total area of about 1.2 hectares.
* To improve the hydrological cycle in highly urbanized river basins, the use of permeable paving materials is being encouraged in order to allow rainwater to sink into the ground more easily, and the establishment of facilities for rainwater storage and infiltration is also being promoted.

1-2-5. The Holistic and Systematic Approach to Urban Environmental Policy (Building Eco-Cities, Etc.)

* Since fiscal 1993, the municipalities have been formulating urban environment plans. These provide a basis for consolidated and systematic efforts to form a quality urban environment by reducing the environmental burden (CO_2, etc.), achieving harmony with nature, and creating amenities. Further, to ensure that each municipality serves as a model and leader in implementing these policies, the Model Project for Improvement of the Urban Environmental Base (the Eco-Cities Project) is being promoted in cities designated as Ecological Model Cities by the Minister of Construction. These cities are granted subsidies for the

drafting of urban environment plans (priority improvement programs) and for the greenery facilities, permeable paving, and other improvements contained therein (budgetary allocation for fiscal 1993: \120 million).

* Design costs are subsidized for efficient-energy-use systems which have been classified as Model Projects for Promotion of Urban Management. These are located in areas undergoing extensive urban renewal that are in one of the three metropolitan regions (Tokyo, Osaka, and Nagoya), or in a seat of prefectural government, or in an urban area with population over 250,000.

*Project feasibility studies are subsidized for "environment-harmonized district development," which provides a large number of energy-efficient buildings while integrating the efficient use of energy at the district level through improvement of green areas and other measures.

1-3. The Transport Sector

<The Approach of Policies and Measures>

In fiscal 1990 the transport sector accounted for 18.3% of total CO_2 emissions, mostly due to the combustion of petroleum products in automobile engines, and this share is on the rise. Trends in energy consumption within the sector are as follows: passenger transportation has shown an almost continuous increase, while the trend for freight transportation leveled off for a time but in recent years has been at a high level and still climbing. The factors behind these trends include the increased volume of vehicles on the road due to growing transportation demand and the ongoing motorization of Japanese society, and the worsening of actual fuel efficiency of motor vehicles due to traffic congestion and increasing vehicle size. In both passenger and freight transport, automobiles are responsible for an escalating share---already over 80%---of total energy consumption. To create road transport systems with low CO_2 emissions the following measures have been taken:

First, reducing CO_2 emissions from individual units of transportation by improving their energy efficiency (especially that of automobiles) and encouraging the use of low-emission fuels. Second, improving the efficiency of freight transportation and promoting the use of mass transit systems in passenger transportation. Freight-carrying efficiency is being improved mainly by encouraging the choice of appropriate transport modes through the revitalization of arterial railway and sea transport between medium- and long-distance distribution hubs, and by promoting consolidated cargo transportation at the intracity and district levels. Third, improving the infrastructure to facilitate automobile traffic flow.

<Policies and Measures in Detail>

1-3-1. Reducing Emissions from Individual Units of Transportation

(1) Improving automobile fuel efficiency

[1] Standards based on the Energy Conservation Law

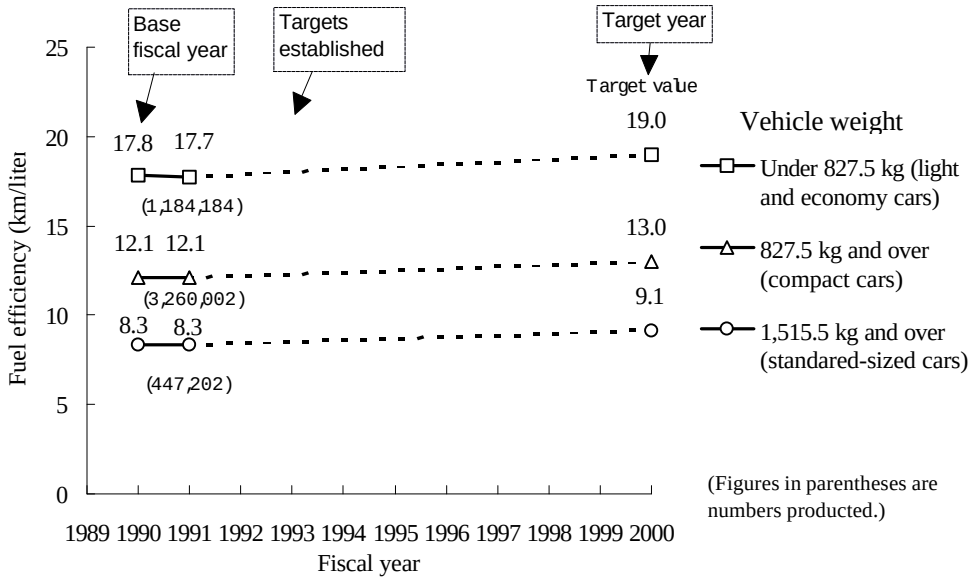
The original Energy Conservation Law required gasoline-fueled passenger vehicles to be designated "specified equipment" by cabinet ordinance at the time of its enactment in 1979. It presented standards for the improvement of energy efficiency and mandated labeling to indicate energy efficiency by the manufacturer or other operator.

The 1993 revision of the law strengthened the guarantees for mandatory labeling. If an operator fails to comply with a recommendation for labeling, the revised law empowers the Minister of International Trade and Industry and the Minister of Transport to make the case public and issue an order. An operator who fails to obey an order is subject to penalty. The original standards were also strengthened in January 1993, and fuel efficiency targets for fiscal 2000 were set at an average of 8.5% improvement over the results for fiscal 1992. (See Fig. 1-3-1.)

[2] Technological development

In fiscal 1993, a system of subsidies was established to promote the commercialization of energy-saving technology. Other efforts in this area include the development of catalyst technologies combining high fuel efficiency with nitrogen oxide (NOx) reduction.

Figure 1-3-1 10-15 Mode Fuel Efficiency Targets Classified in Vehicle Weight



(2) Improving the energy efficiency of other transport modes

* To improve the energy efficiency of railway, sea, and air transport, taxation measures for energy investment are available for lightweight rolling stocks cars, ship's boilers that utilize waste heat, etc.
* In the area of technological development, railway companies are receiving guidance on development and introduction of energy-saving rolling stock technologies. Studies are continuing in the shipping industry, and development of energy-saving aircraft engines is also being promoted.

1-3-2. Introduction of Low-emission Vehicles

In the past, efforts to develop low-emission vehicles have aimed mainly at reducing nitrogen oxides and particulate matter (including smoke particles), and the effort to introduce such vehicles has been led by local public authorities and trucking companies in the major metropolitan areas. In some types of low-emission vehicles already developed, the technology is also effective in limiting CO_2 emissions. Further development is being promoted with the additional consideration of arresting global warming, and measures to support the introduction of low-emission vehicles are being strengthened.

(1) Leadership by the public sector

* The national government put 50 low-emission vehicles in commission with the postal service between fiscal 1992 and 1993.
* At the local public authority level:
  - The introduction of low-emission vehicles as environmental pollution patrol cars is subsidized by the national treasury, and local allocation tax provisions are also available for this purpose. In fiscal 1992, the introduction of 62 such patrol cars was arranged.
  - The introduction of low-emission waste-collection vehicles and municipal buses is supported by funding from municipal bonds, and local allocation tax provisions are also in place for expenses that exceed those of conventional vehicles. In fiscal 1992, the introduction of 25 such vehicles to municipal bus fleets was arranged.

(2) Popularization in the private sector

* In certain areas, subsidies from the Pollution-Related Health Damage Compensation & Prevention Association are available to private enterprises for the purchase of electric vehicles, the lease of methanol-fueled vehicles, and the installation of methanol filling stations. (Local public authorities are also eligible.) The areas covered by this system are centered on districts which were

once designated as having severe and extensive air pollution accompanying commercial or other human activity, together with a high incidence of disease due to its effects. In fiscal 1992, subsidies were granted for 63 electric vehicles, 156 methanol-fueled vehicles (including extension of leases), and one methanol filling station.

* Concerning the measures for the introduction of low-emission vehicles by the government, acquisition (including lease) of compressed-natural-gas-fueled vehicles and fueling equipment for family use have been subsidized since 1994.
* For all owners of electric vehicles, compressed-natural-gas-fueled vehicles, hybrid-engine vehicles, and methanol-fueled vehicles, measures have been taken to reduce the automobile possession taxes levied annually, i.e., automobile tax and (for electric vehicles) mini-sized automobile possession tax, and also to reduce the automobile acquisition tax. Further, taxation measures for energy investment have been instituted for electric, compressed-natural-gas-fueled, hybrid-engine, and methanol-fueled vehicles and for natural gas and methanol filling stations, initially from October 1992 to September 1993, and again for two years from April 1994.
* To promote the introduction of fuel supply equipment for low-emission vehicles, from fiscal 1993 the national government is implementing the Eco-Station 2000 Plan, which grants subsidies to gasoline service stations, etc., that install fuel supply equipment for electric, compressed-natural-gas-fueled, and methanol-fueled vehicles in addition to their conventional fuel pumps.

(3) Promotion of technological development

* In electric vehicles, basic research is continuing on alternatives to lead batteries. Work is also in progress on the manufacture of battery exchange systems, etc., and the development of element technologies such as high-efficiency motors.
* While compressed-natural-gas-fueled vehicles continue to undergo development, studies are also under way to promote their commercialization and wider use.
* Some types of hybrid-engine vehicles have entered commercial production. The technology is still undergoing development to improve performance, make the systems more compact, etc.
* Methanol-fueled vehicles are already in commercial production, mainly in the form of small trucks. Researchers are currently working on further improvements in terms of low emissions, fuel consumption, durability, reliability, convenience, etc.
* With regard to hydrogen-powered vehicles, work is still at the basic research and development stages regarding the various technical problems, such as storing

and carrying hydrogen.

1-3-3. Improving the Efficiency of Freight Transportation

Because of their convenience and mobility, trucks presently handle a major share of freight transportation and account for more than 80% of its energy consumption. Efforts toward more efficient distribution are being made in the following areas, through the measures discussed in detail below: encouraging the choice of appropriate transport modes through the revitalization of arterial railway and sea transport between medium- and long-distance distribution hubs (by improving railways ships, ports, access roads, etc.); promoting consolidated cargo transportation in intracity distribution; actively using commercial carriers; and building distribution centers.

(1) Encouraging the choice of appropriate transport modes through the revitalization of railways and sea transport

* Measures to improve railways:
  - In order to boost capacity by increasing the length of container trains on major trunk lines, a system established in fiscal 1991 supports the extension of departure and arrival tracks and related work at freight terminals by means of interest-free loans and other assistance from the Railway Development Fund.

* Measures for coastal shipping:
  - To promote the building of container ships and roll-on roll-off vessels suited to carrying small cargo lots, since fiscal 1992 the ship adjustment system (which enabled effectively no-scrap building) has been relaxed. Introduction of the space charter system, in which a number of shipping companies make space on their container ships mutually available, is also being encouraged.
  - Under the 8th Five-Year Investment Plan for Ports and Harbors (which covers fiscal years 1991-1995 and calls for a total investment of \5.7 trillion), as of fiscal 1993 work was under way at 23 ports to provide domestic unit-load terminals adapted to ferries and container vessels, etc.

* The following measures have been taken to support the provision of equipment that helps promote railway and shipping use: fixed asset taxes have been reduced on private containers for railway transportation; taxation measures for energy investment have been instituted for forklifts that use sheet pallets, etc.; and a system of loans, mainly from the Japan Development Bank, was established in fiscal 1992 to assist in providing facilities for cargo handling, storage, loading, and unloading, and container storage (container deposit spaces), and for container chassis pools to store trailers.

* As supporting materials, manuals are being prepared and distributed to advise on

how to make optimum use of railway and shipping and provide district-by-district information.

* In technology and system development, studies are under way for commercialization of on-rail trailers and Techno-Superliners.

(2) Promoting consolidated cargo transportation in intracity distribution

* To promote active use of commercial trucks and joint distribution, low-interest loans by the Japan Development Bank were made available in fiscal 1992 for joint distribution centers. Also, based on the Law Concerning Efficient Operation of Physical Distribution by Small and Medium Enterprises (effective 1992), when truck operators who are small or medium entrepreneurs form a business cooperative or similar organization, its operations are eligible for interest-free improvement loans from the Japan Small Business Corporation and low-interest loans from the Japan Finance Corporation for Small Business and other agencies, while any joint distribution facilities that the cooperative acquires qualify for preferential tax measures such as special depreciation deductions.

Measures for more efficient distribution are also being taken in districts where commercial and office functions are concentrated, based on the 1994 report "Measures for Efficient Distribution at the District Level" by the Distribution Committee of the Transport Policy Council. The Pollution-related Health Damage Compensation and Prevention Association also has a system to assist local public authorities in building joint distribution facilities, etc.

(3) Building distribution centers

* In cities where road traffic is congested and distribution functions are impaired, or where such conditions are likely to develop, basic policy for the building of distribution facilities has been established according to the Law Concerning Construction of Distribution Business Centers. On this basis, distribution business zones have been designated in city plans and distribution business complexes are being built, with two construction projects under way as of fiscal 1992. In fiscal 1993 this system was reviewed and extended to cover more cities. Assistance was also made available for the work of coordinating joint delivery services and related business accompanying the establishment and operation of joint-use distribution facilities. The assistance takes the form of guarantees of obligation as well as low-interest loans from the Japan Development Bank and other agencies.

* To support the building of multifunctional distribution centers equipped for

freight and information processing, displays, etc., and with conference rooms and other facilities for the joint use of operators, tax credits such as special depreciation have been instituted, and assistance including low-interest loans is available from the Japan Development Bank and other agencies.

* The Japan Environment Corporation carries out programs for the construction and transfer of centralized distribution facilities with a view to preventing air pollution.

1-3-4. Promoting the Use of Mass Transit Systems in Passenger Transportation

Motor vehicles also account for a large share (nearly 60%) of passenger transportation and are responsible for over 80% of its total energy consumption. Efforts are therefore being made to provide mass passenger transit facilities with high energy efficiency and to promote their use. Measures include increasing the carrying capacity of railways and revitalizing bus services.

* To promote the building of Shinkansen and related railway lines on which trains can travel over the main sections at speeds of 200 kph and above, the Railway Development Fund, established in 1991, provides grants and other assistance for construction of the planned Shinkansen lines.
* Measures to promote the upgrading of main narrow-gauge railway lines include interest-free loans by the Railway Development Fund to assist in establishing direct service between Shinkansen and narrow-gauge lines and converting narrow-gauge lines to high-speed service. Urban railways are also being improved through the active use of various forms of assistance.
* For bus transport, efforts are being made to improve driving conditions by establishing bus lanes, installing more automatic approach signals for buses, using prioritizing systems to ensure that buses run on time, and removing illegally parked cars. To improve bus service, subsidies are available for the introduction of traffic operation management systems, bus location systems, and general information systems. Sixteen such projects were implemented in fiscal 1992.
* Building of urban monorails and new transport systems is being promoted through subsidies. In fiscal 1992, these were granted for 11 lines.

1-3-5. Improving Road Infrastructure to Facilitate Traffic Flow, Etc.

* The need for road improvements to help arrest global warming is specifically addressed in the 11th Five-Year Plan for Road Improvement, which covers fiscal years 1993-1997 and entails a total investment of \76 trillion. The plan calls for three main types of countermeasures: [1] steadily improving the road

system by building bypasses and loop roads, redesigning intersections, etc., in order to save fuel consumption due to traffic congestion. The target traveling speed to be achieved by the beginning of the 21st century is about 10% more energy-efficient than present speeds. [2] providing better access to Shinkansen stations, airports, and harbors; improving roads to promote the use of bus services; improving traffic node facilities for more convenient connections; and improving roads and related facilities at traffic nodes to encourage use by pedestrians and cyclists. [3] improving the provision of road traffic information to drivers by implementing the new Vehicle Information & Communication System (VICS).

* The consolidation and upgrading of traffic control systems is addressed in the 5th Specific National Five-Year Project for Traffic Management Systems Installation, which covers fiscal years 1991-1995 and involves a total expenditure of \2.015 trillion. In fiscal 1993, traffic control centers (which control traffic signals by computer, supply traffic information to drivers, etc.) underwent performance upgrades and traffic signals were equipped with more sophisticated technology such as point response, which adjusts the length of the green phase to traffic volume. Other projects included: illegal parking prevention systems, in which television cameras and speakers are used to monitor illegally parked vehicles and issue warnings; and Travel Time Measurement and Information Systems, which advise drivers of the time required to reach their destination.

1-4 The Energy Conversion Sector

<Approaches of Policies and Measures>

The energy conversion sector is where primary energy sources such as oil and coal are used to produce secondary energy sources such as electricity and city gas. Two steps are being taken in this sector to improve the efficiency of energy use and promote the formation of an energy supply structure that reduces carbon dioxide emissions: first, efforts are being made to improve the efficiency of electric power generation, and second, efforts are being made to introduce energy sources that produce little or no carbon dioxide emissions.

<Policies and Measures in Detail>

1-4-1. Promoting More Efficient Electric Power Generation

One effective way to combat global warming is to reduce the relative amount of fossil fuels used in thermal power-generating plants.

Until now, improved efficiency has been promoted for economic reasons, and

has been achieved by increasing the capacity of power-generating facilities and by raising the temperatures and pressures used to produce steam. In the second half of the 1950s, efficiency in terms of single-plant capacity was about 32%, which was improved to 39.8% by the early 1960s. Subsequently, large-scale, million-kilowatt facilities boosted efficiency to above 40%, and, with the introduction of combined-cycle power generation in existing LNG thermal power plants in the late 1980s, which utilizes waste heat, an efficiency rate of approximately 45% was achieved.

Recently, improved combined-cycle technologies have been introduced in new LNG thermal power plants (with gas-turbine temperatures ranging between 1300C and 1500C), which have further boosted power generation efficiency to approximately 47%. Currently, technologies are being developed with the aim of achieving an efficiency rate of 50%.

In the coal-fired thermal power field, super-critical and ultra-super-critical power-generation technologies, which raise the temperatures and pressures used to produce steam, have improved efficiency from 41% to approximately 42%, and the use of pressurized fluidized-bed combustion technology, which utilizes waste heat, has further boosted efficiency to about 43%. Future improvements will be made through combined-cycle power generating technology using coal gas. To achieve this goal, financial assistance is being provided to promote the development of coal-gas combined-cycle technologies and other high-efficiency power generation methods, and the Japan Development Bank is providing low-interest financing for the development and introduction of coal- and LNG-fired thermal power generation technologies.

1-4-2. Introduction of Energy Sources That Produce Little or No Carbon Dioxide Emissions

(1) Development and Use of Nuclear Power Generation Predicated on the Assurance of Safety

The establishment of nuclear power plants and other power generating facilities is governed by a number of laws, including: The Law for the Adjustment of Areas Adjacent to Power Generating Facilities; the Tax Law for Promoting the Development of Electric Power; and the Special Account Law for Promoting the Development of Electric Power. On the basis of these laws, the Japanese government collects taxes from the power companies and formulates measures to use the collected funds to help cover operating expenses incurred in constructing public facilities and in establishing the foundation for private industry on the proposed plant site and adjacent areas. These measures are designed to improve the welfare of the region in question and to ensure that the project proceeds smoothly with the understanding and cooperation of the local community.

* As of the end of March 1994, Japan had 47 operating nuclear power reactors generating electricity, with a combined generating capacity of 38,541 million kilowatts. As of the end of fiscal 1992, nuclear power generating capacity accounted for 18.7% of Japan's total generating capacity; in that year, nuclear power plants generated 228.3 billion kilowatt-hours of electricity, or 28.2% of Japan's total electric power output (for use by the electric power industry).
* To ensure that the development and use of nuclear power is approached systematically and comprehensively, based on the understanding and cooperation of the Japanese people and premised on the assurance of safety, the Prime Minister's Atomic Energy Commission formulated a Long-term Program for Development and Utilization of Nuclear Energy, which outlines related guidelines and sets basic policies. Actual implementation is carried out according to the Basic Policy for the Development and Utilization of Nuclear Energy, which is formulated on a year-to-year basis.
* Safety is one of the most important prerequisites for smooth progress in the nuclear power field. Many measures have been formulated to ensure safety, including: safety regulations; operational control; radiation exposure control; radioactive waste control; safety research; safety verification and testing of nuclear power facilities; environmental radioactivity surveys; disaster prevention policies for areas surrounding power plants; and research and surveys concerning warm waste water. Safety regulations are set according to legislation such as the Law for Regulation of Nuclear Source Material, Nuclear Fuel Material and Reactors, which is consistently implemented by various governmental agencies to regulate such areas as: nuclear reactor facilities; nuclear fuel facilities; the processing and disposal of radioactive waste; the transport of nuclear fuel materials; and handling facilities for radioactive isotopes. In addition, the Prime Minister's Nuclear Safety Commission provides independent verification of the results of safety surveys conducted by the various administrative agencies involved, if requested to do so by those agencies.

(2) Promoting the Introduction of LNG in the Electric Power and Gas Industries

Since Japan's second oil crisis, LNG has been promoted as a fuel for electric power generation and as a raw material for city gas because of the following advantages: little is lost when it is produced and supplied; it has high thermal efficiency; and it produces low carbon dioxide emissions as compared with other fossil fuels. For these reasons, various support measures have been formulated to promote LNG use, such as: developing and introducing LNG thermal power plants; promoting the use of natural gas by regional city gas companies; expanding industrial demand; and

disseminating gas air conditioners. In addition, gas cogeneration systems are being developed that use town gas and other fuels as an energy source. LNG accounted for approximately 41 million kilowatts of thermal electric power-generating capacity as of the end of fiscal 1992, or 22.3% of Japan's total power generation capacity, a share that is considered appropriate in terms of the overall composition of Japan's electrical power sources.

* The Japan Development Bank has established a low-interest, long-term financing program for the development and introduction of LNG thermal power plants. To promote the introduction of natural gas by regional gas companies, the government provides interest subsidies for natural-gas conversion costs, provides training and technical guidance, and leases facilities.
* To encourage the construction and renovation of facilities needed for industrial applications of LNG, and to install the bases and transportation infrastructure necessary for regional gas companies to convert to LNG, the Japan Development Bank and other financial institutions have established low-interest, long-term financing programs, and the government has instituted taxation measures for energy investment.
* The Japan Development Bank has established a low-interest, long-term financing program to encourage the installation of air conditioners that run on city gas. Also, efforts are being made to develop the technology for ultra-compact gas air conditioners for use in private homes.

(3) Hydroelectric Power

* Given Japan's steep, mountainous topography, hydroelectric power represents one of Japan's greatest domestic energy resources. In fiscal 1992, Japan possessed a hydroelectric power-generating capacity of approximately 38 million kilowatts, representing about 20.8% of total capacity. Future developmental efforts will center on small and medium-sized hydroelectric power-generating facilities, including such activities as: testing and standardizing new design and operating technologies; developing flow calculation methods that use remote sensing technology; developing computer systems to carry out planning and basic design; and ascertaining the usefulness of technologies for coping with decrepitude in existing power-generating facilities.

(4) Geothermal Power

* As of the end of fiscal 1992, Japan had 10 sites where shallow hydrothermal systems were used to generate a total of 270,000 kilowatts. Six more sites

capable of producing about 230,000 kilowatts are now being prepared for operation. The current status of research and development in this field is as follows.

- Studies are being conducted on ways to reduce the investigative risks involved in evaluating resource quantities, and effective investigative methods for fracture-type reservoir strata, which are the dominant type in Japan, are being developed and tested.
- Concerning new power-generating systems, research and development is being carried out on two energy sources that have not been used in previous geothermal systems: medium-hot water and hot dry rock.
- Since fiscal 1992, efforts have been made to develop survey and extraction technologies for deep geothermal resources, which would contribute to the immediate expansion of production capacity at existing geothermal sites.

(5) Development of New and Renewable Energy Sources

In July 1991, the Prime Minister approved the Basic Plans for Research and Development on Energy, which outline the energy R&D projects in which the Japanese government should play a central promotional role.

In addition, various projects have been pursued under the Sunshine Project, a comprehensive R&D project begun in 1974 that focuses on the development of new and renewable energy resources. In 1993, the Sunshine Project was combined with the Moonlight Project (a comprehensive project for the development of energy-conserving technologies) and other technological development projects for the conservation of the global environment to create the New Sunshine Program.

For information concerning power generation through waste incineration, please see the section concerning the waste management sector.

[1] Solar and Solar-thermal Power

- Many successes have been achieved in solar power generation under the Sunshine Project. The basic technology is essentially established, and it is now possible to use an interconnection system, though at a high cost. As of the end of March 1993, Japan was capable of generating approximately 3,600 kilowatts using solar power.
- Technical achievements through fiscal 1992 include the following: Conversion efficiencies of 17.2% for 10cm^2 polycrystalline solar cells and 12.0% for 10cm^2 amorphous solar cells have been achieved. In addition, research has yielded basic knowledge concerning ultra-high-efficiency solar cells.

Concerning systems technology for solar power generation, improvements have been made in the performance of peripheral equipment such as inverters and racks, and technologies have been developed that permit the manufacture of low-cost racks for general home use.

- Currently, the introduction of solar-generated electricity is impeded by high costs. Therefore, measures are being formulated to promote its introduction in the early stages, and efforts are being made to address such technical issues as cost reduction.

- For information concerning private-use solar-heat systems, please see the section concerning the Residential and Commercial Sector. Technical development continues on solar-thermal systems for industrial use.

- To promote the introduction of solar power-generating systems, the systems are being installed on a trial basis in public facilities, and data concerning their operation under actual loads are being collected and analyzed. Beginning in fiscal 1994, subsidies will be available to help cover the operating costs for monitoring residential power-generation systems, and the costs of installing solar cell power-systems in individual residences. In this way, the installer will also act as a system monitor, resulting in equipment with higher performance capabilities that match consumer needs.

[2] Wind Power

- Research has been conducted on 100-kilowatt wind-activated power plants, and the technology for small and medium-sized wind-activated power plants has essentially been established. Applications, however, are still limited to testing and research, isolated islands, and demonstrations, with a total generating capacity of 2,000 kilowatts as of the end of fiscal 1992. Future issues that must be addressed include improving efficiency by increasing the size of the generating facilities, and establishing concentrated wind-power generation systems that can generate electrical power on an appropriate scale. Since fiscal 1990, control technology has been developed for large-scale, 500-kilowatt class power generation systems and for concentrated power generation systems (consisting of two 250-kilowatt generators and six 100-kilowatt generators). In addition, a map of wind conditions is being prepared that shows the average annual wind speed in all regions of Japan.

Because of Japan's unique climatic and geographical conditions, however, the areas where wind power can be introduced are somewhat

limited.

[3] Ocean Energy

-Various kinds of wave power-generation technologies are being developed, including: floating oscillating-water-column systems; shore-fixed systems; pendulum systems; and wave-energy-absorption breakwater systems that convert the energy of the waves into the flow of air. Approximately 500 wave-activated generators are currently used on navigational buoys in Japan.

-Regarding ocean-thermal-conversion power-generation systems, closed-cycle technologies are being developed that use ammonia and other media. Although demonstration operations have been completed at a pilot plant, it seems unlikely that a power plant based solely on this technology will be economically feasible. As for open-cycle systems that use seawater as the direct working fluid, the elemental technologies are being developed according to a plan that will be completed around the year 2000.

(6) Development of New Energy Supply Systems

High-efficiency energy supply systems currently under development include: more efficient power generation and electrothermal supply systems that improve overall efficiency; energy storage systems that boost the efficiency of facility operations; and systems that make use of dispersed energy sources.

Work on these various technologies is being conducted as part of the Moonlight Project, a comprehensive plan established in 1978 dedicated to the development of energy-conserving technologies.

To date, results have been achieved in the following areas: the practical use of an absorption heat-pump system as part of the development of waste-heat utilization systems; magneto-hydrodynamic electricity generation systems (MHD); high-efficiency gas turbines; general-purpose Stirling engines; and advanced battery-type electric energy storage systems.

For more information concerning the use of previously unexploited energy sources such as urban waste heat, see the section concerning the Residential and Commercial Sectors.

[1] Fuel Cells

Regardless of the scale of the facility in which they're used, fuel cells have a high electrical power generating efficiency ranging from 40% to 60%. When used in combination with a system that utilizes waste heat,

overall efficiency increases to 80%. For this reason, fuel cells are being developed for use in local energy stations serving small communities, and as on-site batteries for facilities where electrothermal supply is possible.

- The following activities are being pursued with regard to phosphoric acid fuel cells: 1,000-kilowatt plants for use in the electric power industry are being developed and operated; on-site, 200-kilowatt plants are being developed and operated with the aim of achieving practical applications; and field tests and technical development of plants with capacities of approximately 100 kilowatts are being implemented.
  Concerning molten carbonate fuel cells, operational research is currently under way on a 100-kilowatt class pilot plant and, in fiscal 1993, work began on the design of a 1-megawatt pilot plant. Developmental research is also being conducted on the elemental technologies for solid oxide fuel cells and polymer electrolyte fuel cells.

[2] High-efficiency Gas Turbines and Related Technologies

- In recent years, the efficiency of thermal power plants has improved to over 40%, but work continues on developing high-efficiency gas turbines that will further improve power generating efficiency. In addition, technology is being developed for ceramic gas turbines for 300-kilowatt industrial use engines.
- To improve the efficiency of coal-fired thermal power plants, the following activities are being pursued: trial operation of large-scale (350,000-kilowatt) fluidized-bed combustor for electric power generation; evaluation of the environmental impact of pressurized, fluidized-bed, combustor combined-cycle power generating systems; and materials testing for ultra-high temperature (649¡C) turbines.

[3] Leveling Out Power Loads

- Demand-side management (DSM), which sets different electricity usage fees depending on the time of day, has been introduced to accommodate the difference between daytime and nighttime energy demand. In addition, energy storage systems such as pumped storage generators and thermal storage tanks are being used, and studies are being conducted on technologies such as seawater-pumped-storage generators and compressed-air-storage gas turbine generators. Technologies being researched for future use include super heat-pump energy collection systems that store waste heat and other forms of heat at high densities, and dispersed-type

power storage batteries.

- Other activities aimed at leveling out power loads include the testing of load-centralized control systems that permit the energy supplier to directly control the equipment of energy consumers, and the development of ultra-compact gas air conditioners for home use.

[4] Superconducting Technologies

- Practical superconducting technologies are being developed to enable the expansion of power-source capacities, and to alleviate problems (such as locating power-line construction sites and suffering increased power loss during transmission) that are encountered as power plants are built further away from the areas where the energy is consumed. Research and development is also being carried out on superconducting generators, total systems, and refrigeration systems.

1-4-3. Supportive Measures to Promote the Dissemination of New and Renewable Energy Sources and New Energy Supply Systems

Cogeneration, solar power generation, and other new technologies are essentially established. Various financial, tax, and systemic measures have been formulated for the following purposes: to promote the introduction of technologies that are not being disseminated because of high costs; to support the establishment of facilities that equalize demand; and to encourage the development of local energy sources.

(1) Financial and Tax Measures

* The Japan Development Bank has established a long-term, low-interest financing program to promote the introduction of fuel cells, combined-cycle generation systems, and cogeneration systems.

* Taxation measures for energy investment have been formulated to encourage the use of facilities that use energy sources that replace fossil fuels, including: solar power-generation facilities; wind power-generation facilities; equipment that uses geothermal power; equipment that uses solar-thermal power; fuel cells; gas turbines for use in combined-cycle power generation; and cogeneration plants. The same measures apply to heat-storage air conditioners and other equipment that helps to level off energy demand.

* Support is provided for business feasibility studies and model operations that promote the development and use of local energy sources that are closely tied to energy supply and demand in local communities, such as natural energy, waste

heat, and energy derived from trash. Interest subsidies are also available to local public authorities and private groups that are involved in the development and use of local energy.

(2) Regulatory Relaxation and Other Systemic Measures

* Electric power in Japan is supplied by power companies that conduct business on the basis of the Electric Power Industry Law. The power companies are subject to regulations stipulated by this law, including requirements such as obtaining approval for plans to build electrical structures. In 1990, however, these regulations were relaxed with regard to solar power-generation plants, fuel-cell power-generation plants, and wind power-generation plants.
  - Only a report need be submitted when constructing small-scale structures. For structures smaller than a specified size, the report requirement is also waived.
  - Measures have been adopted that permit safety associations and other organizations to take charge of appointing chief engineers for small-scale projects. In addition, technical standards have been established, and efforts have been made to simplify and facilitate legally required technical inspections.
* Progress has been made in developing guidelines concerning the technical requirements for interconnecting electrical power systems and home-based power-generation equipment. In April 1993, guidelines were established for the sale of excess electrical power produced by small-scale companies and individuals.
* In February 1994, a purchasing menu was established for excess electricity produced by such dispersed sources as solar, wind, waste, and cogeneration power-generation facilities.

1-5. Cross-Over Sector

<The Approach of Policies and Measures>

The cross-over sector encompasses policies, such as recycling, promoting appropriate packaging, and using environmental markings, which "cross over" into a variety of fields and contribute to the realization of a lifestyle that conserves energy and resources. Cross-over policies require coordinated action by both consumers and businesses, and their effects are seen in all stages of the consumption cycle, from production through consumption and disposal.

Recycling, for example, not only reduces carbon dioxide emissions resulting from waste incineration (which accounted for 3.8% of all carbon dioxide emissions in 1990), but also greatly reduces the amount of energy used to process raw materials into finished materials. Cross-over policies are discussed below in addition to policies related to social systems, such as the shortening of labor time, which also affect energy consumption.

<Policies and Measures in Detail>

1-5-1 Promoting Recycling

* In 1991, the Law Concerning the Promotion of the Utilization of Recyclable Resources (Recycling Law) was promulgated, which promotes the use of recyclable resources by 1) establishing basic policies; 2) defining the responsibilities of concerned parties; and 3) outlining particular measures applied to businesses.

- The basic policies establish recycling goals and include items designed to deepen public understanding concerning the importance of promoting the use of recyclable resources. The responsibilities of concerned parties include: efforts on the part of businesses to use recyclable resources and promote the recycling of their products or by-products; efforts on the part of consumers to fulfill their obligation to use recyclable resources; and efforts on the part of national government and local public authorities to provide capital and promote scientific and technical development in the recycling field.
- Concerning particular measures applied to businesses, the law specifies which business fields should promote the use of recyclable resources as raw materials, and categorizes products and by-products as follows: products that should be recycled after they are used and discarded (Category I Products); products that should be marked to facilitate separated recovery after they are used and discarded (Category II Products); and materials created as by-products of manufacturing and other processes for which recycled use should be promoted (Designated By-products). For each business directly or indirectly involved in manufacturing or using these specified products and by-products, the competent ministry formulates standards that serve as the basis for decision-making on the

part of the said businesses with regard to promoting the use of recyclable resources, as well as standards for labeling. These standards are enforced by the competent minister through a system of measures that includes guidance, advice, warnings, public proclamations, and orders. In 1993, the list of designated products was expanded to promote the recycling of items such as sealed alkaline storage batteries.

Table 1-5-1 Designated Industries, Category I and Category II Products, and Designated By-products

Designated Industries (Types of Recycled Materials)	Papermaking (waste paper); glass-container manufacturing (cullet); construction (sand and gravel, concrete chunks, asphalt/concrete chunks)
Category I Product	Cars; unit-type air conditioners; television receivers; electric refrigerators; electric washing machines; power tools; personal computers; cordless telephones; telecommunications devices used in car and mobile radios; ham radios; Japanese-; language word processors; video cameras; headphone stereo systems; electoric vacuum cleaners; battery-run shavers; electoric tooth brushes; electoric medical-treatment home use; motorized toys (automobile type).
Category II Products	Beverage cans; polyethylene terephthalate containers for beverages and soy sauce; sealed alkaline storage batteries.
Designated By-products (Industry)	Slag (ironmaking industries that use blast furnaces, and steelmaking and steel-rolling industries); coal ash (electric utilities industry); sand and gravel, concrete chunks, concrete/asphalt chunks, and wood materials

* Support Measures to Promote Recycling

- Various support measures have been formulated on the basis of the Energy Conservation and Recycling Assistance Law, which was promulgated in 1993. According to the law, the competent minister establishes and publicizes guidelines for the autonomous efforts of businesses to promote the use of recycled resources. Support measures (including debt guarantees and interest subsidies, tax deductions or special depreciations, monetary reserves, and special taxation measures such as deductions for technical development) have also been formulated as well as support measures to help small and medium businesses promote recycling. These measures apply in cases where appropriate actions are taken by businesses in accordance with established guidelines, including: the establishment and renovation of facilities that contribute to the promotion of recycling; the separated recovery of recyclable resources and the development of markets for products made from recycled materials; the development of technologies that make it easier to use recycled materials in manufacturing processes; the development of construction technologies that utilize recycled resources; and the establishment of manufacturing facilities for products made of materials that can easily be used as recycled resources.

  The goal of increasing the recycled-resource utilization ratio by 2.2% or

more annually has been set for the approximately five-year duration of the above program, which was designed to encourage the autonomous efforts of business. This is a higher rate of growth than has been achieved in the past.

- Other measures have been formulated to support recycling, including tax deductions and special rebates for the establishment of manufacturing facilities that produce recycled paper and plastics. From 1993, these measures were expanded to include facilities that utilize waste as a raw material. In addition, the Japan Development Bank and other financial institutions have established low-interest, long-term financing programs for the establishment of facilities for transporting, storing, recovering, and processing recycled materials such as waste paper and glass cullet, as well as facilities for manufacturing products that can be converted into recycled resources.

* In 1990, various governmental ministries and agencies agreed on measures to promote their own use of recycled paper and to reduce waste. By 1993, all 28 ministries and agencies were using recycled toilet paper, and the ratio of recycled paper used in envelopes and copy paper had reached 96% and 86%, respectively. In postal operations, approximately 20 million "eco-postcards" made of recycled paper were used in 1992, and approximately 520 million such cards were used in 1993.

* Various surveys and research projects are also being conducted to promote recycling, including studies on the utilization of recycled materials in cars, recycled paper, and recycled cans, as well as the actual use of recycled paper in new products. Research is also being conducted on deposit systems and other economical measures, and surveys are being carried out on promoting the recycling of alcoholic-drink containers.

1-5-2. The Use of Environmental Marks

* Environmental marks are placed on products that are judged by objective standards to be gentle on the environment. The Eco Mark and Green Mark are used on labels in Japan and are playing an increasing role in promoting the purchase of environmentally friendly products and raising consumer consciousness concerning environmental conservation.

- The Eco Mark program was instituted in February 1989. As of the end of May 1994, it was used to designate 2,538 product brands in 58 categories, including products that incorporate recycled paper pulp, hot-water supply systems that use solar heat, and heat insulating materials for construction applications. The Green Mark is used to designate paper products that use recycled paper. Under this program, which is designed to raise public awareness concerning

the preservation of the natural environment and the conservation of forest resources, schools and other institutions that collect a certain number of Green Marks become eligible to receive saplings, bulbs, and products made of recycled paper.

Figure 1-5-1 Environmental Marks

Eco Mark

Green Mark

The Eco Mark expresses our commitment to "protecting our Earth and environment with our own hands"

1-5-3. Promotion of Appropriate Packaging

* In 1991, guidelines were formulated to encourage more appropriate packaging practices, including the reduction of packaging material. Organizations involved in the packaging field are required to comply.

  Organizations involved in the food industry are also required to formulate their own packaging standards. As of April 1992, 11 such organizations had established autonomous standards designed to address such issues as controlling excess packaging.

1-5-4. Shortened Working Time and Daylight Savings Time

* In 1988, revisions in the Basic Labor Law went into effect that in principle reduced the annual average of total actual working time for individual Japanese workers from 48 hours per week to 46 hours per week, and this was further adjusted to 44 hours per week in April 1991. As a result, actual working time has steadily decreased, from 2,044 hours in fiscal 1990 to 1,958 hours in fiscal 1991.

  The current goal for reducing individual working time is set by the Five-Year Plan to Improve Living Conditions in Japan, which went into effect in June 1992. The plan stipulates that a total annual working time of 1,800 hours should be achieved by the time the plan expires in fiscal 1996.

* Recently renewed consideration has been given to daylight savings time as a method to use energy efficiently and increase leisure time and as a way to review the national lifestyle.

2. Measures to Enhance Carbon-Dioxide Sinks

(Land-Use Changes and Forests)

<The Approach of Policies and Measures>

Sixty-seven percent of Japan's land is covered by forest, a high forestation ratio that has been maintained at about the same level for many years. While Japan's forest resources continue to grow more replete, 80% of its artificial forests (which constitute 41% of its total forests) are not yet ready for harvest, and must therefore be tended for some time to come. The forestry and wood industries, on the other hand, are less able to provide appropriate forest care because of severe economic conditions stemming from depressed lumber prices, competition from non-wood materials, increased wood-product imports, and other factors. To ensure the comprehensive, high-level use of the many functions forests provide, the Japanese government has formulated a Nationwide Forest Plan that promotes appropriate forest policies, designates as protected forests those forests that provide strong public benefits, and institutes measures such as permission systems for the development of private forests. In addition, the plan helps develop diverse forest resources through the implementation of nurturing and thinning programs, as well as multi-storied forest operations and tended natural-forest works.

Through forest maintenance programs, efforts are also being made to promote the efficient use of wood materials, which are a renewable resource.

In addition, appropriate measures are being implemented on the basis of an overall understanding of nationwide vegetation (including forests) for the purpose of protecting Japan's forests, which constitute the very core of its natural environment. Applied to areas that require environmental protection, these measures include the designation of: wilderness preservation areas; natural preservation areas; and natural park areas.

In urban areas, greenery is being protected and increased through comprehensive programs that include public projects and greenery promotion programs.

<Policies and Measures in Detail>

2-1. National Land Use Plan

The National Land Use Plan was formulated to promote the comprehensive and systematic use of national land. The current nationwide plan was formulated in 1985 with the target year of 1995, and serves as the basis for other plans. Table 2-1 shows the targeted size of total land area assigned to each land-use category.

Table 2-1 Targeted Size of Land Area Assigned to Each Land-use Category
(Units: 10,000 hectares; %)

	1982	1995	Proportion of Total 1982	Proportion of Total 1995
Agricultural Land	554	559	14.7	14.8
Cultivated Land	543	550	14.4	14.6
Grazing Land	11	9	0.3	0.2
Forest Land	2,533	2,535	67	67.1
Natural Grassland	32	23	0.8	0.6
Water Surface	131	136	3.5	3.6
Road	103	127	2.7	3.4
Building Land	145	170	3.9	4.4
Residential Land	90	106	2.4	2.8
Factory Land	15	17	0.4	0.4
Other Building Land	40	47	1.1	1.2
Other Land	280	230	7.4	6.1
Total	3,778	3,780	100	100
Urban Area	100	133	・|	・|

Notes
1.Land-use categories for 1982 are based on surveys conducted by the National Land Agency.
2.Roads include general roads, farm roads, and forest roads.
3.Urban areas refer to densely inhabited districts defined in the population census of Japan. The 1982 urban area is the area of densely inhabited districts according to the 1980 population census of Japan.

2-2. Forest Conservation Programs

Efforts to systematically conserve Japan's forests and pursue sustainable management practices are carried out in accordance with forest planning systems on the basis two laws: the Forestry Basic Law and the Forest Law.

2-2-1 Formulation of Forestry Plans

* The forest planning system was radically revised in 1991. Many different forestry plans have been established, with guidance and support provided for their formulation, including: the Basic Plan for Forest Resources, the Nationwide Forest Plan, the Forest Improvement Operation Plan, Regional Forest Plans, Plans for National Forests by Geographical Region, and Forest Operation Plans. In addition, the government conducts surveys to promote forest planning, develops technologies for forest surveys, and collects data.

- The Nationwide Forest Plan is formulated in accordance with basic governmental plans concerning forest resources, as well as long-term predictions regarding demand for important forest products. Prescribed by the Minister of Agriculture, Forestry, and Fisheries every five years, the plan clarifies goals and other matters associated with forest improvement in all of Japan's forests on the basis of 15-year periods. The current plan provides guidelines for 44 different wide-area river basins.
- The Forest Improvement Operation Plan is formulated by the Minister of Agriculture, Forestry, and Fisheries to help achieve the goals outlined in each

Nationwide Forest Plan by specifying implementation goals and the operating budget for the first five years of each Nationwide Forest Plan. The current Forest Improvement Operation Plan covers five years from fiscal 1992 and establishes an operating budget for that period of \3.9 trillion.

- In accordance with the Nationwide Forest Plan, prefectural governments formulate separate Regional Forest Plans for private forests in 158 different planning regions, most of which comprise river basins. These plans establish forest locations, areas, and improvement goals according to forest function. For nationally owned forests, comparable plans are formulated by the heads of the central government's Regional Forestry Offices and other officials.

  Regional Forest Plans encourage systematic forest conservation and improvement through various measures, including the requirement that private forest owners receive permission before engaging in forest development.

- Forest Operation Plans are five-year plans formulated by forest owners that specify time periods, geographical areas, and other particulars of harvesting and reforestation activities. They can be submitted to prefectural governments for certification. When multi-storied forest operations and long-term harvesting are required to maintain and expand the public benefits derived from certain forested areas, owners can also draw up special forest operation plans that facilitate such activities in those areas and submit them for certification.

  As of the end of fiscal 1992, the total area certified under Forest Operation Plans was 12,640,000 hectares, of which 10,989,000 hectares were certified under joint forest-operation plans implemented by public housing developments, which were designed to promote the forest operations of small-scale forest owners.

- For national forests, an Operations Management Plan was formulated from scratch in fiscal 1992 that established appropriate forest operations for the following four forest types: national conservation forests; forests for natural sustenance; forests for recreational use; and forests for the production of lumber. In addition, the plan establishes a system for designating as protected forests certain areas that are particularly important from the standpoint of environmental conservation. As of the end of January 1994, 779 areas totaling 380,000 hectares have been designated as protected forests.

- In fiscal 1993, measures were adopted to support local governments that engage in special improvement operations in forests designated for environmental conservation and forests designated for public benefit. Efforts in these areas permit local governments to seek increased funding from the central

government, which in turn provides the foundation for calculating both the amount of municipal bonds that can be floated and the amount of local allocation taxes.

2-2-2 Designation of Protected Forests

* The protected-forests system is used to designate forests (especially those with strong public-benefit functions) as protected forests, thereby ensuring that the public gets maximum use from them by specifying appropriate conservation measures and forest operations. Conditions are set concerning how trees are harvested, how many are harvested, and how reforestation is implemented. Licensing is required if trees are to be harvested or damaged, or if the topography of the land is to be changed, and reforestation is required if trees are harvested. A plan for the development of protected forests was formulated, and protected forests are being quickly and systematically established. As of the end of fiscal 1991, approximately 8.86 million hectares were designated as protected forests, representing about 35% of Japan's forested area or about 24% of its total land area.

2-2-3 Basic Development Through Afforestation

* The Eighth Five-year Plan for Forest Conservation (fiscal 1992 through fiscal 1996) was formulated to provide basic policies for the investment of \2.76 trillion with the following aims: to create the foundation for land that is safe, refreshing, and rich; to promote forest development in water-source areas; and to preserve and create green living environments. The plan promotes various projects designed to conserve national land through the development of: forests that control flooding in mountainous regions; protected forests; forests in water-source areas; and forests that prevent landslides.
* To quickly and systematically create forests in water-source areas, a profit-sharing afforestation program is being steadily implemented by the Forest Development Corporation. In fiscal 1992, the corporation provided approximately \30.9 billion yen in aid for this program, resulting in the creation of 5,800 hectares of forest. In addition, the Corporation systematically promoted the establishment of councils comprised of people involved in forest-related industries in each river basin, with the aim of revitalizing the forestry and wood industries. Along with providing financial support for council activities, the Corporation provided assistance for guidance activities at Centers for the Vitalization of River-basin Forestry, which are operated by prefectural governments. The Corporation's budget for these activities in fiscal 1992 was \110 million.

2-2-4 The Improvement of Forests Through Appropriate Management

* The five-year Forest Improvement Operation Plan begun in fiscal 1992 is dedicated to the improvement of forests through such basic activities as afforestation, thinning, and forest-road construction and maintenance. Specifically, the plan systematically promotes investment for the following activities: reforestation, tree-breeding, and thinning; multi-storied forest operations; long-term harvesting operations; tended natural-forest works; the establishment of sites for health, cultural and educational activities; the establishment of forest roads to revitalize the forestry industry; and the development of living environments in mountain villages.

- Assistance is provided for afforestation activities in private forests. In fiscal 1992, assistance was provided in the following categories: artificial afforestation of single-storied forests (33,000 hectares); tree-breeding (331,800 hectares); development of multi-storied forests (4,100 hectares); development of tended natural forests (22,900 hectares); and improvement of unproductive forest land (400 hectares). In addition, preferential measures have been formulated to promote afforestation and silviculture on a profit-sharing basis, and efforts are being made to promote the development of forest development corporations, which are important implementing agents for such activities.

  Activities in national forests in fiscal 1992 included the natural afforestation of 79,000 hectares (including the afforestation of 12,000 hectares through natural-forest breeding operations) and the artificial afforestation of 7,000 hectares. In addition, multi-storied afforestation was undertaken on 1,000 hectares.

- Concerning the procurement of elite plant seedlings, technical development is being promoted at the Forest Tree Breeding Center, which was established in 1991. Assistance is also being provided to prefectural governments engaged in elite-plant seed selection activities. For national forests, plant-breeding seedlings are being produced through the cloning of elite trees.

- In 1990, 1.4 million hectares of forest were identified as needing emergency thinning during the following five years. A plan was formulated under which assistance and other forms of support have been provided for such activities as building access roads, developing machinery, and establishing distribution and processing facilities. In fiscal 1992, 95,300 hectares were thinned, 446.7 kilometers of access roads were constructed, 376 production, distribution, and processing facilities were built, and 30 areas were prepared for joint regional thinning operations. The goals for fiscal 1993 are 58,700 hectares, 483.2

kilometers, 376 sites, and 60 areas, respectively.

- Support has also been provided for the construction of a network of forest roads, including 1,871 kilometers of general-access roads, as well as roads built through forestry structure improvement projects. In 1991, 517 kilometers of forest roads were constructed in national forests.

* To support sustainable forest management, various other policies and programs are being pursued, including: policies to prevent forest damage from disease and insects; policies to encourage young people to enter the forestry business; forestry structure improvement projects, including the prioritized and efficient implementation of projects such as the construction of facilities in designated regions; projects for establishing a domestic wood production and distribution system; and projects for the development and improvement of high-performance forestry equipment. Various funding measures have also been formulated, including: long-term, low-interest financing by the Agriculture, Forestry and Fisheries Finance Corporation; financing by the Wood Industries Development Fund for the rationalization of wood production and distribution; a system of debt guarantees by the Agriculture, Forestry and Fisheries Credit Fund; and loans from Forestry Improvement Funds.

Table 2-2 Main Measures for Promoting Forestry Operations

(Unit:¥1 million)

Type of Activity	Budget (FY 1993)
Afforestation	52,684
(Portion of above accounted for by national forests)	-8,602
Procuring elite seeds and seedlings	821
Building forest roads	107,156
Measures to strengthen the promotion of thinning	6,584
Measures to prevent forest damage by disease and insects	4,503
Development/improvement of high-performance forestry machine	333
Training the personnel to be in charge of forestry, and forestry extension business	5,131
Comprehensive measures for dried wood supply	555
Projects for establishing domestic wood production and distribution systems	1,245
Forestry structure improvement projects	19,257

* Profit-sharing projects, in which parties other than the forest owner engages in afforestation activities and shares the resulting profits with the owner, have been implemented since fiscal 1983. In 1992, approximately 800 hectares of forest were planted through profit-sharing projects. Since 1983, about 10,400 hectares of national forest have been planted through the public recruitment of participants in profit-sharing projects; similarly, about 3,958 hectares of private forest have been planted since 1976.

In addition, a middle-term profit-sharing silviculture system was introduced in fiscal 1984, in which parties other than the national government agree to pay

a portion of the counter value and silviculture expenses of the trees, and subsequently split the profit with the government when the trees are harvested and sold. Contracts for approximately 1,700 hectares were signed in fiscal 1992. Since 1984, about 67,000 people have participated in the system, covering a total of area of approximately 20,500 hectares.

* Financial support is also provided to promote autonomous local forest protection efforts on the part of forest owners and local residents, including the development of fire-prevention organizations and forest patrol groups.

2-3. Conservation of Nature

2-3-1. Designation of Nature Conservation Areas

* The Nature Conservation Law is designed to comprehensively promote the appropriate conservation of Japan's natural environment. On the basis of this law, areas that are especially in need of conservation are designated, and forests, which constitute the core of Japan's natural environment, are properly preserved.

- The national government has formulated Basic Policies of Nature Conservation, which outline fundamental natural conservation measures. In addition, the government ensures that the natural environment on national lands is maintained in its pristine state, unaffected by human activity, and designates as wilderness areas those regions that are in special need of protection. In principle, development, removal of plants, and other activities that affect natural conservation are banned in wilderness areas, which also contain designated areas where public access is restricted. The government also designates as nature conservation areas certain regions consisting largely of superior natural forests that require conservation for both natural and social reasons. To ensure appropriate conservation, more detailed regional designations are made in accordance with the degree to which restrictions on development are needed.

  As of the end of fiscal 1993, five wilderness areas totaling 5,631 hectares, 10 nature conservation areas totaling 21,593 hectares, and 515 prefecture-designated nature conservation areas totaling 73,380 hectares have been designated, most of which consist of forested areas.

2-3-2. Designation of Natural Parks

* Japan's Natural Parks Law, which provides the basis for the designation of natural parks, is formulated according to fundamental concepts of natural conservation.

Natural parks are appropriately managed according to the degree to which restrictions on development are needed, and are classified by categories that include special areas, special protection areas, and ordinary areas.
As of the end of fiscal 1993, Japan's natural parks consisted of 28 national parks (2.05 million hectares); 55 quasi-national parks (1.33 million hectares); and 301 prefectural natural parks (1.95 million hectares). The combined area of these parks, of which approximately 80% is forested, is 5.33 million hectares, or 14% of Japan's total area.

2-3-3. Disseminating a National Trust

* The activities of Japan's National Trust, which acquires and manages land for the purpose of conserving green areas and good natural environments near urban centers, are being promoted in all regions of the country. To support those activities, preferential tax measures have been formulated that permit contributions to certain corporations promoting National Trust activities to be deducted separately. In addition, symposiums are being held to educate the public about the Trust.

2-4. Studies on the Effects of Acid Rain and Other Pollutants on Forests

* Two surveys concerning countermeasures against acid rain have been conducted, the first one beginning in 1983. Although nationwide precipitation was found to have a pH value ranging between 4 and 5, the effects of that precipitation on the ecosystem are still not clear at this time. A third survey was begun in fiscal 1993 with a budget of \75 million for that year. From fiscal 1990, research has been conducted on the effects of acidic substances on the ecosystem. To better understand the actual effect on forests, the government is also conducting on-site forest surveys, running sample analyses, and creating a database from the results over a period extending from fiscal 1990 through fiscal 1996. The budget for this research for fiscal 1992 was \127 million.

2-5. Conservation of Greenery in Cities and Other Developed Areas

2-5-1. Greening of Factory Sites

* According to the Factory Location Law, any factory that is newly established with a total area of 9,000m^2 or more, or with a building area of 3,000m2 or more, must devote at least 20% of its total area to greenery, and submit a report to the government. In 1973, 5.8% of all factories in Japan met the criteria for greenery established by the law, covering a total of 6,300 hectares; by 1992, those figures

had climbed to 13.8% and 21,300 hectares, respectively. Various measures have been formulated to promote the greening of factories, including long-term, low-interest loans available from the Japan Development Bank and the Small Business Finance Corporation, and assistance from the Japan Environment Corporation for the construction of green areas to prevent air pollution and green buffer zones to prevent industrial pollution.

2-5-2. Greening of Facilities for Public Use and Benefit

* Greening measures are being implemented for various facilities dedicated to public use and benefit, including rivers, harbors, roads, water treatment plants, governmental facilities, and schools. Measures are tailored to the special characteristics of each type of facility.

2-5-3. Other Urban Greenery Programs

* As described in Section 1-2-4 of this report, "Alleviating the Heat Island Phenomenon by Promoting Urban Greenery and other Measures," various plans are being formulated and activities pursued with regard to greening urban areas. In addition, the government is: 1) designating core areas for urban greening efforts; 2) establishing model areas for the promotion of greenery, with emphasis on the establishment of city parks; and 3) establishing urban arboretums designed to heighten city dwellers' awareness of greening efforts and disseminate knowledge concerning plant cultivation. In fiscal 1992, activities were carried out in three core areas, six model areas, and 26 arboretums. To supply trees for public urban greening programs, the government also budgeted \854 million in fiscal 1992 for the operation of 11 tree farms.
* The government also designates as "urban green-space conservation areas" certain green areas that are appropriate for use as urban buffer zones, and as "suburban green-space conservation areas" certain areas that are particularly effective in promoting greenery in the suburbs of the Tokyo and Kinki metropolitan areas. In addition to restricting development in these areas, the government buys land, spending \2.251 billion in fiscal 1992 to purchase approximately 2.6 hectares.

2-6. Promoting the Effective Use of Wood Resources

* Many measures are being taken to comprehensively promote the effective use of wood resources, which serve to store carbon. These include: promoting the development and introduction of plywood manufacturing facilities that use wood from coniferous trees; promoting the introduction of facilities that

contribute to the rationalization and modernization of wood processing and distribution; promoting the development and distribution of wood products manufactured by means of advanced processing methods; promoting the use of wood in combination with other materials for the construction of large wooden structures; commending regions that are superior producers of domestic wood; supporting efforts to expand demand for wood; and collecting, analyzing, and providing information concerning trends in wood demand and supply. Also, to promote the development of new applications for wood, the government promotes the use of wood in interior decoration, and is working to develop technologies for the use of wood extracts.

* The government also provides special rebates for facilities that crush and recycle used wood materials.

2-7. Technical Development

* Historically, the development of forest conservation and afforestation technologies in Japan has been achieved through operations carried out in domestic forests. Recently, however, research and development have been promoted in connection with tropical rain forests, including afforestation techniques that accommodate the special characteristics of tropical regions, and breeding techniques for useful tropical trees. To help prevent desertification, developmental work is also being done on forest restoration technologies and water-supply chemicals used for land improvement. In addition, support is being provided for projects, including one that focuses on the uses of kenaf, which will help conserve forests by developing substitutes for wood pulp. Also, test operations are being conducted with the aim of systematizing cultivation equipment so that greening activities can be conducted on rooftops, high bridges, and other locations that have been inaccessible to greening efforts in the past.

3. Measures to Limit Methane Emissions

3-1. The Waste Management Sector

<The Approach of Policies and Measures>

Landfill disposal of refuse accounted for approximately one-half of Japan's methane (CH_4) emissions in FY 1990. Although the overall volume of refuse is trending upwards, intermediate processing and resource recovery have tended to reduce the volume that is ultimately landfilled. Nonetheless, efforts to cut back the volume of landfill will continue to be needed.

CH_4 countermeasures are being implemented in three principal areas: (1) waste reduction, (2) upgrading of treatment facilities so as to reduce the volume of landfill, and (3) structural modification of final disposal sites to reduce their susceptibility to methane emissions.

Incineration of refuse accounted for 3.8 percent of carbon dioxide emissions in FY 1990. Although measures to cut refuse volumes also have the effect of reducing carbon dioxide emissions, other measures are simultaneously being implemented to cut consumption of fossil fuels by utilizing energy generated from refuse incineration.

<Policies and Measures in Detail>

3-1-1. Promotion of Waste Volume Reduction and Recycling

* In October 1991, Japan's Waste Management Law underwent revision. Founded in an awareness of the importance of undertaking society-wide efforts for proper disposal, including volume reduction and recycling, the revisions undertake to specify the responsibilities of the public, businesses, and central and local government, with three chief thrusts: (1) promotion of waste volume reduction and recycling, (2) ensuring proper treatment and disposal, and (3) upgrading of treatment and disposal facilities.

First, promotion of waste volume reduction and recycling of refuse. The new legislation explicitly cites as goals control of waste emissions, segregation and sorting of refuse, and recycling. It also specifies the responsibilities of the public and spells out citizens' obligation cooperate with the efforts of central and local governments by limiting wastes, utilizing recycled products, and segregating and sorting garbage. Specific measures provided for in the legislation include the following:

- The revised law provides measures for reduction of refuse and specifies the kinds of municipal refuse to be segregated for collection under Municipal Waste Management Plans. It also establishes the reduction of waste as an integral element in Industrial Waste Management Plans.
- The law permits municipalities to establish Waste Reduction Promotion Councils and to appoint Waste Reduction Promotion Advisors (private individuals working in a voluntary capacity).
- The law allows mayors to direct large-scale producers of refuse to draw up waste reduction plans. Prefectural governors may direct commercial businesses that produce large volumes of industrial waste to draw up disposal plans.
- When setting disposal fees, municipalities must take into account the characteristics of municipal wastes and the cost of disposal.
- To foster recycling and recovery businesses, the revised law institutes a system by which these firms must register with prefectural governors, and makes it

possible for municipalities to require cooperation registered firms to cooperate in their programs.

- To promote resource recovery, the law permits the Minister of Health and Welfare to request the ministers responsible for the administration of the relevant industries to provide guidance concerning the labeling of product materials and disposal methods.

* Efforts are being made to segregate paper waste and empty cans from other refuse. In FY 1989, a program to establish integrated facilities for waste recycling was introduced; under this program, assistance is now being provided for facilities to exhibit examples of resource recovery, discarded items that have been repaired, and recycled products ("Recycling Plazas"). Since FY 1992, assistance to municipalities has been stepped up with the addition of a new program to aid recycling centers for cans and bottles, and other measures.

  Communities collecting sorted garbage for resource recovery rose from 703 in FY 1989 and 786 in FY 1990, to 1079 in FY 1991. As of June 1993, their number had climbed to 1,342, or 41.5 percent of all municipalities in Japan.

  In recent years, moreover, a growing number of local bodies have begun charging fees for garbage collection and disposal, with a direct impact on waste producers' awareness of costs. As of October 1992, 1,134 municipalities, or 35%, charged some form of waste disposal fee.

* Manufacturing and distribution (including wholesaling and retailing) industries have been asked to cooperate in promoting resource recovery and further reduction of trash volumes, in recovering used paper and utilizing recycled paper, in voluntarily limiting the use of disposable containers, and in establishing recovery and disposal routes for discarded products. In addition, local organizations are offering periodic programs to recover trash for recycling. Local communities are taking steps to support these efforts.

* Funds are provided to assist with the construction of sewage treatment facilities that put sewage sludge to good use through composting and conversion into construction materials.

3-1-2. Upgrading of Treatment and Disposal Facilities

* Waste treatment and disposal in Japan is regulated by the Waste Management and Public Cleansing Law, referred to below as the Waste Management Law. The law distinguishes between municipal wastes, e.g., the trash generated by citizens in the course of their everyday lives, and industrial wastes generated by business activities, and specifies waste disposal methods for each category.

  - Disposal of municipal wastes is performed by local communities, municipal

waste management businesses, and waste producers, on the basis of disposal plans drawn up by municipalities for their localities. Trash undergoes final disposal either directly, or after intermediate processing.

Central government assistance for the establishment of waste management facilities amounted to 156.3 billion yen in FY 1993, disbursed for 699 facilities throughout Japan. Under the Seventh Waste Treatment Facilities Construction Promotion Plan, drawn up to cover the period from FY 1991 to FY 1995, a total of 2.83 trillion yen has been committed to improvement of facilities, an investment figure 50 percent higher than the previous plan.

- Disposal of industrial wastes is the responsibility of the waste producer, and is conducted either by the enterprise itself, or by contracting to a waste management business. Prefectural governors are charged with drawing up management plans to cover industrial wastes.

  Industrial waste disposal facilities are being upgraded under the Law concerning Promotion of Improvement of Specific Facilities Relating to Disposal of Industrial Wastes, enacted by the Diet (Japan's parliament) in 1992. The law provides for long-term low-low interest loans and bond guarantees for industrial waste management plants that construct facilities for research and development, training, or public exhibition.

3-1-3. Promotion of Semi-Aerobic Landfill

Technical standards for landfill sites specify that these should be equipped with aeration equipment and drainage facilities for speedy elimination of water. This maintains air circulation in the landfill and cuts back methane-producing decomposition by anaerobic bacteria.

3-1-4. Recovery of Energy from Wastes

Efforts are being made to utilize heat generated by waste incineration for hot water supplies for in-house use in incineration plants and nearby facilities, and in area heating. Power generation from incineration is increasing year by year: as of the end of FY 1992, 116 trash disposal facilities generated about 363 megawatts of electricity; 56 of these sell their electricity to power utilities.

* Under the government's general program of upgrading waste management facilities, financial assistance is provided for the new construction and renovation of refuse incineration generation plants operated by local public bodies.

  Funding is also provided to assist with the construction costs of plants to convert wastes into solid fuel.

* Measures have been adopted to enable local public bodies to issue bonds for those projects that generate power sales from incineration at municipal waste disposal facilities (since FY 1992), and in high-efficiency powergeneration projects, in which waste incineration is combined with other appropriate heat sources (since FY 1993).
* Under the government's programs to improve sewage treatment facilities, funds are provided to assist with construction costs for power generation projects burning digestive gas from sewage treatment.
* The Japan Development Bank, the Japan Environment Corporation, and the Small Business Finance Corporation provide finance for businesses that establish facilities for the recovery of wastes as resources. Preferential tax treatment, in the form of tax deductions and special depreciation allowances, is provided for resource recovery and recycling plants.
* The Japan Development Bank and other institutions commenced lending programs in FY 1992 for businesses setting up electricity generation plants burning refuse as fuel. Interest subsidies are provided to businesses that establish facilities using heat from incineration. In addition, the Japan Environment Corporation advances loans for facilities that utilize surplus heat, when these are conjoined with industrial waste disposal plants.
* Taxation measures to promote investment for improvement of the energy supply-and-demand structure are extended to equipment that generates electric power from wastes.
* Research and development of technology to recover energy from wastes is being undertaken in the following areas:
  -Electric power generation from wastes: R&D is being conducted to improve generating efficiency (currently at about 10%), to develop systems for power generation in small plants, to apply technology to boost steam temperatures and pressures, and to eliminate metal erosion from hydrochloride gas.
  -Development of energy recovery systems: This includes technology to enhance decomposition and solubility of wastes in order to maximize methane manufacture, and to enhance the methane-generating fermentation using low/mid temperature waste heat.
* In the area of resource recovery, research and development is being undertaken to develop technologies:
  - To recover metals from incinerator ash, to dispose of chlorides using fusion, and to convert slag into building and construction materials.
  - To separate and extract useful materials from by-products and wastes produced by the food industry during manufacturing processes, and to develop these as

materials for use in food and other industrial products.

3-2. The Agricultural Sector

<Policies and Measures in Detail>

Countermeasures against methane and nitrous oxide are still at the research and evaluation stage, as follows:

* Paddy Fields

In order to limit methane emissions from paddy fields, the following studies are being conducted on methane generation factors that have a significant impact:

- Release of methane from paddy fields was studied as part of a project begun in FY 1990 to clarify sources and volumes of CH_4 and N_2O. The present study seeks to develop an optimal method of measuring the flux of methane released into the atmosphere, to elucidate the daily and seasonal changes in the flux, and to analyze the processes governing the generation, decomposition, and methane transport in the paddy field soil. Results so far include development of automatic flux measuring equipment, implementation of continuous measurement during the rice-growing season, studies of the relationship of methane concentrations in paddy-field soil and water and the methane flux, and analysis of the methane transport mechanism.
- Experimental studies are also being conducted to improve technology for soil and fertilizer management. Tests of emission volumes are being conducted in farms throughout the country with the aim of establishing conditions of fertilizer types and water management in districts with different climates, soils and crops to develop methods to prevent methane emissions. Study was also given to farm management methods conducive to lower methane emissions.

* Livestock:

- A study aimed at realizing and disseminating new technology to process farm animal wastes is being conducted: field studies were conducted to construct technology systems for the fermentation and sewage disposal of livestock wastes. In FY 1994, 69 million yen was allocated to this project.

Methane emissions from ruminant livestock were included in the above-mentioned project to clarify sources and emissions of CH_4 and N_2O. The study seeks to determine the methane volumes emitted by cattle, sheep and goats, and establish the relationship between methane emissions and such factors as volume of fodder intake, feed makeup, and rumen (first stomach) fermentation

products, in order to develop a straightforward method of estimating methane emissions. Among the results so far: analysis of the relationship between methane generation and fodder varying ratios of hay and concentrated feed indicates that methane generation can be estimated from the volume of dry fodder intake. On the basis of this finding, a simple estimation method has been drawn up using regression analysis.

3-3. The Energy Supply and Other Sectors

* Coal Mining:
  - Under the provisions of the Mine Safety Law, boring is conducted at high-methane coal mines prior to the commencement of mining work so as to prevent gas explosions and irruptions; the gas thus obtained is used as fuel. In addition, it is also possible to utilize methane gas from closed coal mines as fuel. In other cases, methane permeating from coal-bearing strata is exhausted from the mine: this is constantly monitored and the measured values reported to the Ministry of International Trade and Industry.
  - Natural Gas Development: Prevention of leaks is important from the perspective of conserving resources, in addition to pollution prevention. The Petroleum and Inflammable Natural Gas Resources Development Law requires mining methods that prevent gas leakage. As in the case of coal mining, measures also are mandated under the Mine Safety Law to prevent accidents. Leaks of natural gas at the mining and production stages are thought to be minimal.
* Methane emissions from city gas supplies are tiny: city gas leakage is prevented under the application of safety rules for the construction and operation of gas facilities (LNG plants, pipelines, etc.) in the Gas Utility Industry Law, and the safety standards of individual gas utilities.

4. Measures to Limit of Nitrous Oxide Emissions

<Policies and Measures in Detail>

In the manufacturing, agriculture, transportation, and waste management sectors, research is being undertaken to obtain quantitative data on nitrous oxide (N_2O) formation and emission volumes, and technology development is being undertaken to control emissions.

4-1. Studies of Emissions

* Nitrous oxide emissions has been studied since FY 1990 under the Project to Clarify the Sources and Emissions of CH_4 and N_2O:

- Waste Management: N_2O concentrations in exhaust gases and the exhaust gas volumes were measured and the emission factors calculated for both a standard mechanical-grate batch-combustion incinerator (10t/8h) and an advanced model (12.5t/8h) designed and operated for complete combustion. Measurements were taken at periodic intervals from fire-up to shut-down of the incinerators.

  Emission factors were sought for the principal reactor tanks of sewage treatment facilities employing standard and high-load de-nitrification methods, on the basis of measurements of the concentrations of the gas generated and the gas released by the facilities. Small septic tanks employing a combination of anaerobic filtration and contact aeration were also studied; however, questions remain about how to interpret gas generation data, so emission factors have not yet been calculated.
- Emission from Fertilized Soil: Measurements were made of the nitrous oxide flux from black Ando soil (volcanic ash) when spread with different nitrogenous fertilizers, and measurements were taken of nitrous oxide volumes generated from different soils (yellow soil, Ando soil) under fertilizer application. It was found that slow-acting fertilizer shows low N_2O generation. Experiments are currently underway to measure the gas flux in grasslands, forests, and pastures.
- Emissions Associated with Industrial Activity: A study of a variety of industrial boilers has established an algorithm to compute accurately boiler emission factors, taking into account, the type, size, fuel, and the presence or otherwise of exhaust gas scrubbing equipment. Nitrous oxide emissions from major thermal power stations in Japan were measured in order to estimate their annual emission volumes. In addition, techniques of determining nitrous oxide emissions from stationary sources were collated and evaluated, and measurements made of actual emissions from a variety of smoke-emitting facilities, in an effort to collect data.
- Automotive Emissions: It was originally planned to take measurements using non-dispersive infra-red analysis techniques in order to determine N_2O emissions under continuous operation in typical operating patterns. However, preliminary results indicated that N_2O concentrations in exhaust gas are extremely low, rendering accurate measurement impossible owing to interference from coexistent gases (especially carbon monoxide).

  Study was also given to the N_2O generation and its decomposition by catalysts in cars with three-way catalytic (TWC) converters. Observations were also made of N_2O emission trends in different types of vehicle employing

different types of combustion and emissions control equipment. It was found that the operating temperature range of TWC cars, in which N_2O emissions are a problem, is close to the temperature at which the catalyst becomes active, and that the temperature range is relatively low and small.

N_2O emissions from cars equipped with oxidation catalytic converters are high at the commencement of operation, but are reduced at the end of warm-up, and resemble the emission pattern of TWC vehicles.

4-2. Fertilizer Management Measures

* In FY 1991, a major program of research was begun to evaluate CH and N_2O emissions from agricultural land and to improve methods of soil, water and fretilizer application management. In this project, N_2O emission volumes stemming from the spreading of organic matter and chemical fertilizers are being studied, and data collected to establish countermeasure technology. Experimental studies are also being made with respect to farm management methods conducive to low N_2O emissions. (In FY 1993, 181 million yen was budgeted for this project.)

Also in FY 1991, an project was launched for the experimental introduction of regulated-action fertilizers was launched. Slow-acting fertilizers, have been experimentally applied across the board, and monitoring has begun of N_3O-N in underground water and N_3O emissions into the atmosphere. The results will provide the basis for drawing up policies for the utilization of slow-acting fertilizers so as to encourage their general application. (In FY 1993, 41 million yen was budgeted for this project.)

5. Measures to Limit Emissions of Other Greenhouse Gases

<The Approach of Policies and Measures>

Systematic controls are now in place for nitrogen oxides (NOx), carbon monoxide (CO), and hydrocarbons (HC), the standards restricting their emissions having already been specified in the Air Pollution Control Law. Although scientific understanding of the contribution of these gases to global warming is incomplete, existing measures will be retained for the time being.

<Policies and Measures in Detail>

5-1. Establishment of Environmental Quality Standards

* Environmental quality standards, representing emission levels desirable from a health safety standpoint, have been established for nitrous oxide (N_2O) and carbon monoxide (CO). For nitrous oxide, the mean hourly value per day is set

in the range of 0.04 ppm to 0.06 ppm or lower, and for carbon monoxide, at 10 ppm or lower, with a total of 20 ppm or lower mean hourly value for any 8-hour period.

The thinking underlying the setting of environmental quality standards recognizes the growth of absolute pollution volumes from cumulative sources and seeks to clean up overall accumulated pollution through comprehensive implementation of a variety of measures. Unlike "tolerance limits" or "acceptable levels," environmental quality standards are in the nature of desirable levels that are to be attained and then maintained. They represent administrative policy goals towards the achievement of which other administrative intervention is targeted, and unlike emissions standards, are not regulatory standards to be adhered to by businesses with conformity secured by legal penalties.

Although environmental quality standards are not defined for non-methane hydrocarbons, guidelines have been established concerning the concentrations necessary to achieve the environmental quality standards for photochemical oxidants (an hourly value of 0.06 ppm or lower), namely a 3-hour mean of 0.20 ppmC - 0.31 ppmC or lower for the period from 6 am to 9 am.

5-2. Measures to Control Nitrogen Oxides from Stationary Sources

* Measures are implemented under the Air Pollution Control Law to limit nitrogen oxide (NOx) emissions from smoke-emitting facilities such as boilers in factories and other work sites.

- Across-the-board nationwide emission standards have been defined for different types and sizes of smoke-emitting facility, and outlet concentration tolerance limits have been instituted. Since regulation began in 1973, the standards have been strengthened on five subsequent occasions and new facilities have been added to the inventory of those covered. As of FY 1991, 26 kinds of smoke-emitting facilities, or just over 90 percent, are now covered by the standards.
- In FY 1981 a system of area-wide total pollution load controls on nitrogen oxides was inaugurated under the Air Pollution Control Law. Under the system, the Prime Minister designates specified areas in which factories and businesses are concentrated and in which it is deemed difficult to ensure environmental standards under restrictions on individual smoke- emitting facilities (currently: specific wards in Tokyo, Yokohama and surrounding areas, and Osaka and surrounding areas). Prefectural governors with a designated area in their jurisdiction then draw up total volume reduction plans, on the basis of which, area-wide total emission standards are defined, each

factory or place of business above a certain size within the specified area being treated as a single unit (specified factory). The standards represent the tolerance limits for the total volume of nitrogen oxides emitted from all smoke-emitting facilities located within the premises of a specified factory.

- Means of enforcing the emissions standards and area-wide total pollution-load controls include, in addition to legal penalties, prior registration of smoke-emitting facilities, restrictions on the installation of new facilities, and the authority to order changes in proposed installation plans, upgrading of facilities, or temporary suspension of operation.

* Incentives are available to promote development of nitrogen oxide (NOx) scrubbing technology: the Japan Environment Corporation, the Japan Development Bank, the Small Business Finance Corporation, and the People's Finance Corporation offer low-interest long-term loans to businesses for smoke-stack scrubbing equipment, and special tax incentives, including accelerated depreciation and reduced estimated lifetimes, also apply.

5-3. Measures to Control Motor Vehicle Emissions

* Measures to control emissions of nitrogen oxides (NOx), carbon monoxide (CO), and hydrocarbons (HC) from motor vehicles are implemented under the provisions of the Air Pollution Control Law: the Director General of the Environmental Protection Agency determines the tolerance limits for vehicle exhaust gases, and the Minister of Transportation determines what rules are necessary to restrict motor vehicle emissions under the safety regulations provided for the Road Vehicles Law, in order to secure those levels. Conformity is guaranteed under the vehicle inspections mandated by the Road Vehicles Law.

  The restrictions on automotive emissions have been strengthened on several occasions. Current tolerance limits are shown in Table 5.1. [SHOWN ON OTHER SHEETS]

* The December 1989 Central Council for Environmental Pollution Control recommended that stringent cutback goals be instituted for nitrogen oxide emissions from diesel-powered vehicles. Studies are now being undertaken towards the realization of the long-term goals recommended by the Council. (Table 5.2) [SHOWN ON OTHER SHEETS]

* In June 1992, the Law Concerning Special Measures for Total Emission Reduction of Nitrogen Oxides from Motor Vehicles in Specified Areas was enacted, principally in order to abate pollution from these sources in Osaka City and surrounding areas. Under this legislation, areas where the air is egregiously

polluted by automotive nitrous oxide emissions have been designated (196 municipalities in the Saitama, Chiba, Kanagawa, Osaka, and Hyogo Prefectures and in the Tokyo Metropolitan area), and the central government has drawn up a basic policy for total emission reductions in the specified areas. The policy incorporates goals for the reduction of overall automotive nitrogen oxide emissions, calls for wider use of low-emission vehicles, and discusses basic matters bearing on the flow of goods, people and traffic. Governors of prefectures containing specified areas have then drawn up total volume reduction plans, which detail measures to be implemented in connection with the reductions prescribed in the central government policy (which seeks to more or less achieve the environmental standards for nitrous oxide emissions by the end of FY 2000). In the case of wider use of low-emission vehicles (described in 1-2-2), the plans set as target a goal of 300,000 of these vehicles operating in the designated areas by the end of FY 2000.

One special provision of this legislation is the establishment of emission standards for designated vehicles, primarily buses and trucks, based in the designated areas. Since December 1993 restrictions have been implemented on the kinds of vehicles that can be driven: vehicles that fail to meet the standards are not granted warrants of fitness. In addition, policies to foster rationalization of vehicle use in the manufacturing and transportation industries have been adopted by the cabinet ministers with jurisdiction over these industries. Measures pertaining to the improvement of freight shipment efficiency are also being implemented as described in 1-3-3, under these policies.

* The Japan Development Bank and the Small Business Finance Corporation advance low-interest loans to businesses when they scrap and replace diesel trucks and buses that do not meet emissions standards of the areas specified in the above legislation. Scrapping and replacement is further promoted by accelerated depreciation for motive power units (corresponding to the internal combustion engine), tax deductions, and abatement of motor vehicle acquisition tax.

* A variety of surveys and studies are under way to enable these restrictions to be implemented appropriately. A study is being conducted of emissions from fossil fuels, examining emissions from existing stationary sources and tolerance limits of automotive exhaust gas, and evaluating exhaust gas reduction technology.

As to fixed sources, an area-wide total pollution control manual and a variety of other guidelines have been compiled (dating back to the 1980s) and an ongoing study (1988--) has been conducted for measures against small-scale sources. A survey has also been made for measures to deal with air pollution

during the winter period.

With respect to mobile resources, preliminary studies have been scheduled in the period 1992 through 1994 to determine the extent of ownership and use of motor vehicles that are not currently covered by the restrictions, their emission status, and technology to reduce emissions. In the period 1990 through 1996, technical guidelines for reducing exhaust gas from low-emission diesel and methanol-fueled vehicles are slated to be drawn up. Also studies have been conducted since 1986 concerning experimental introduction of methanol as automotive fuel, with approximately 1.4 billion yen budgeted for this project in 1992.

Table 5-1 Automotive Exhaust Gas Control Values

Type of vehicle			Mode	Component	Year instituted (FY)	Control value	Remarks
Gasoline & LPG	Passenger cars	4-cycle and 2-cycle	10¥15M (g/test)	CO	1975	2.70 (2.10)	
				HC	1975	0.39 (0.25)	
				NOx	1978	0.48 (0.25)	
			11M (g/test)	CO	1975	85.0 (60.0)	
				HC	1975	9.50 (7.00)	
				NOx	1978	6.00 (4.40)	
	Trucks and buses	4-cycle light vehicles	10¥15M (g/km)	CO	1975	17.0 (13.0)	
				HC	1975	2.70 (2.10)	
				NOx	1990	0.74 (0.50)	
			11M (g/test)	CO	1975	130 (100)	
				HC	1975	17.0 (13.0)	
				NOx	1990	7.50 (5.50)	
		2-cycle light vehicles	10¥15M (g/test)	CO	1975	17.0 (13.0)	
				HC	1975	15.0 (12.0)	
				NOx	1975	0.50 (0.30)	
			11M (g/test)	CO	1975	130 (100)	
				HC	1975	70.0 (50.0)	
				NOx	1975	4.00 (2.50)	
		Light vehicles (GVW <= 1.7t)	10¥15M (g/test)	CO	1988	2.70 (2.10)	
				HC	1988	0.39 (0.25)	
				NOx	1988	0.48 (0.25)	
			11M (g/test)	CO	1988	85.0 (60.0)	
				HC	1988	9.50 (7.00)	
				NOx	1988	6.00 (4.40)	
		Medium-weight vehicles (1.7t < GVW <= 2.5t)	10¥15M (g/test)	CO	1975	17.0 (13.0)	
				HC	1975	2.70 (2.10)	LPG 105 (76)
				NOx	1994	0.63 (0.40)	LPG 6.80 (5.40)
			11M (g/test)	CO	1975	130 (100)	
				HC	1975	17.0 (13.0)	
				NOx	1994	6.60 (5.0)	
		Heavy vehicles (2.5t < GVW)	G13M (g/kWh)	CO	1992	136 (102)	
				HC	1992	7.90 (6.20)	
				NOx	1995	5.90 (4.50)	
Diesel vehicles	Passenger cars	10¥15M (g/km)		CO	1986	2.70 (2.10)	
				HC	1986	0.62 (0.40)	
				NOx Subcompacts	1990	0.72 (0.50)	
				Compacts	1992	0.84 (0.60)	
				PM	1994	0.34 (0.20)	
	Trucks and buses	Light vehicles (GVW <= 1.7t)	10¥15M (g/km)	CO	1988	2.70 (2.10)	
				HC	1988	0.62 (0.40)	
				NOx	1993	0.84 (0.60)	
				PM	1993	0.34 (0.20)	
		Medium-weight vehicles (1.7t < GVW <= 2.5t)	10¥15M (g/km)	CO	1993	2.70 (2.10)	
				HC	1993	0.62 (0.40)	
				NOx	1993	1.82 (1.30)	
				PM	1993	0.43 (0.25)	
		Heavy vehicles (2.5t < GVW)	10¥15M (g/kWh)	CO	1994	9.20 (7.40)	
				HC	1994	3.80 (2.90)	
				NOx Direct injection	1994	7.80 (6.00)	
				NOx Secondary chamber	1994	6.80 (5.00)	
				PM	1994	0.96 (0.70)	

Note: Items in parentheses are average values.

Table 5-2 Tolerance Level Target Values (NOx)

Vehicle Type				Current Controls		Long-Term Goals
				Mean value	Year implemented	Target value
Diesel	Trucks and Buses	Light vehicles (up to 1.7t GVW)		0.6g / km	1993	0.4g / km
		Medium-weight vehicles (more than 1.7t and up to 2.5t GVW)		1.3g / km	1993	0.7g / km
		Heavy vehicles (more than 2.5t GVW)	Direct injection	6.0g / kWh	1994	4.5g / kWh
			Secondary chamber	5.0g / kWh		
	Passenger cars		EIW<=1.25t	0.5g / km	1990	0.4g / km
			EIW>1.25t	0.6g / kWh	1992	
Gasoline	Trucks and buses	Medium-weight vehicles (more than 1.7t and up to 2.5t GVW)		0.4g / km	1994	・©
		Heavy vehicles (more than 2.5t GVW)		4.5g / km	1995	・©

Notes:
1. GVW: Gross vehicle weight; EIW: equivalent inertial weight (gross vehicle weight plus 110 kg, equivalent to the weight of two passengers).
2. The following conversion equivalencies are employed:

g/kWh	g/PSh
4.5	3.31
5	3.68
5.5	4.05
6	4.41

Table 5-3 Emission Standards for Special Vehicles

Type of vehicle, by weight	Standards applied to new vehicles up to August 1995			Standard applied to new vehicles from Sep-95	
	Standard value		Measurement mode	Standard value	Measurement mode
Up to and including 1.7t	Gasoline	0.48 (0.25) g/km	10¥15 (10)	0.48 (0.25) g/km	10¥15 (10)
	Diesel	0.48 (0.25) g/km or 100 (70) ppm	10¥15 (10) D6		
Over 1.7t and up to and including 2.5t	Gasoline	0.98 (0.7) g/km	10¥15 (10)	0.98 (0.7) g/km	10¥15 (10)
	Diesel	0.98 (0.7) g/km or 210 (150) ppm	10¥15 D6		
Over 2.5t and up to and including 5.0t	Gasoline	600 (450) ppm or 6.9 (5.1) g/kWh	G6 G13	6.8 (5.0) g/km	G13
	Diesel	350 (260) ppm or 6.9 (5.1) g/kWh	D6 D13		D13
Over 5.0t	Gasoline	900 (690) ppm or 9.4 (7.2) g/kWh	G6 G13	7.8 (6.0) g/kWh	G13
	Diesel	520 (400) ppm or 9.4 (7.2) g/kWh	D6 D13		D13

Notes:
1.Standard values have been defined so that the following equivalencies hold between vehicle types under the new controls.

Type of vehicle by weight	Is brought in line with:
Up to and including 2.5t:	gasoline vehicles
Over 2.5t and up to 5.0t:	secondary chamber diesel vehicles
Over 5.0t:	direct injection diesel vehicles

2.Standard values in parentheses are mean values.

6. Promotion of Public Awareness

6-1. Improved Environmental Education: Media Events, Classes, etc.

* Environment-related agencies cooperate in publicity activities through TV, radio, newspapers, magazines, and other media, and in activities such as lending public awareness videos. In addition, they compile and disseminate teaching and informational materials, and support local public bodies in their awareness programs. Both central government and local public bodies undertake a variety of programs centered on Japan's annual Environment Day, established under the Environmental Basic Law on June 5, in commemoration of the June 1972

United Nations Conference on the Human Environment.

- The Japanese government is appealing for positive action to deal with global warming and other environmental issues in its White Paper on the Environment and other publications and documents, and is working to enhance public awareness of environmental conservation through environmental fairs, awards, and events in and around Environment Month, held in June of each year. It also holds and sponsors public lectures and distributes pamphlets and brochures; for example, the Environmental Protection Agency issues a pamphlet on the prevention of global warming that provides the public with accurate information about the mechanisms of global warming, outlines the Action Plan to Arrest Global Warming, and advocates, by way of steps that the public can take, adoption of fuel-efficient vehicles, use of solar energy, installation of insulation, tree-planting, and recycling.
- Local public bodies also undertake a variety of environmental education projects, using Regional Environment Conservation Funds (49.8 billion yen at the end of FY 1992), launched in 1989 with central government assistance. To support these programs, the Japanese government has developed an environment education database, and operates a National Liaison Committee to foster training and exchanges of information. National assistance is also provided to support adult education programs such as seminars on how to practice environmental conservation.

6-2. Improved Education Programs in Schools

* Improved curricular content of environmental education in schools was sought in the March 1989 revision of the Ministry of Education's Curricular Guidelines.

To enhance teacher informedness, supplementary materials for teachers have been compiled. In FY 1994 a new series of environment education fairs and other activities for teachers are scheduled.

6-3. Enhancing Awareness of Resource and Energy Conservation

* To further ensure that efforts for resource and energy conservation take root throughout society, in the summer and winter of each year the Environment Protection Agency draws up seasonal guidelines for energy conservation, to be distributed as pamphlets through government agencies and other organizations, and holds symposia and other activities on the basis of these guidelines.

Specific recommendations made in the guidelines include: targeting room temperatures at about 28¡C for air conditioning and about 20¡C for heating, reduction of the days and hours of air-conditioner use, insulation of buildings,

diligent turning out of lights, and use of energy-efficient machinery and equipment. The first day of each month is declared Energy Conservation Day. August 1 is dedicated as Summer General Checkup Day for Energy Conservation, December 1 as Winter General Checkup Day, and February as Energy Conservation Month. These occasions all provide focal points for public awareness activities.

Organizations to foster a national campaign for resource and energy conservation have been launched by central and local governments; the national and local organizations have jointly held a major national conference to launch their campaign.

To promote the national campaign at the local level, funds have been allocated to prefectural governments, for use in a wide variety of public awareness projects now being implemented.

* To encourage recycling, October has been designated as Recycling Promotion Month. During this month, a Clean Japan Campaign is mounted, with a wide spectrum of public awareness activities including contests for the best recycling idea.

6-4. Campaign to Promote Afforestation

* In 1983, the government established an interagency Afforestation Liaison Committee which reports on the implementation of each year's afforestation campaign and coordinates the campaign schedule for the following year. National afforestation campaign activities are wide ranging, and include the Green Feather Fund-Raising Campaign centered on National Arbor Day, the establishment of afforestation advisory offices and classes, and building up the National Fund for Greenery and Water. In addition, the committee determines the period of the spring Green Town Campaign (April-June) and the Green Town Month (October), conducting a variety of events relating to urban tree-planting projects.
  - The Green Feather Fund-Raising Campaign is conducted by Local Afforestation Promotion Committees each year during March through May, the period when on afforestation and greenery campaigns are at their height. The peak fund-raising period falls during the last 10 days of April, during which period an intensive nationwide campaign of street canvassing is mounted. In FY 1992, 1,264 million yen in donations were received and put to use in a variety of public tree-planting projects.
  - The National Fund for Greenery and Water is a national-level foundation relying on voluntary and spontaneous contributions by citizens and businesses.

Funds received are employed in experiential awareness programs, exchanges between urban and rural communities, and other activities to revitalize rural communities.

6-5. Creation of The Japan Fund for the Global Environment and other Programs

* At the United Nations Conference on Environment and Development, Japan announced that it would improve its machinery for funding assistance to privately-funded private-sector activities in global environmental conservation. To make good this commitment, in May 1993, the Japan Fund for the Global Environment was established within the Japan Environment Corporation with Japanese government and private sector contributions. The Japan Environment Corporation provides grants and other support for afforestation and wildlife conservation activities conducted by Japanese and overseas non-governmental organizations (NGOs) in developing countries, and for afforestation and recycling activities conducted by Japanese NGOs in Japan. In its first year of operation, FY 1993, 104 grant applications from domestic and overseas NGOs were selected to receive a total of 405 million yen in assistance.

In addition, environmental conservation projects by NGOs are eligible for assistance from a variety of other programs; these include the Ministry of Foreign Affairs NGO project subsidies and small-scale grant assistance programs, grants from contributions from the Ministry of Posts and Telecommunications special postcard programs, and grants from the International Volunteer Savings Fund.

6-6. Development of Manuals and Guidelines

Guidelines for activities and case studies of environmental projects are provided for information purposes, in order to ensure that environmental considerations are integrated into all economic and social activities conducted by the many and varied entities that make up Japanese society, (The Environmental Basic Law contains provisions pertaining to the fostering of private-sector activities.) In 1989, for example, the Environmental Protection Agency wrote and distributed "Guidelines for Environmentally Sound Living" and in 1992 "Guidelines for Environmentally Sound Corporate Practices."

7. Scientific Research, Observation, and Monitoring

<The Approach of Policies and Measures>

"The Comprehensive Promotion of Research, Observation/ Monitoring and Technological Development for the Conservation of the Global Environment" was agreed upon by the Council of Ministers for

Global Environment Conservation in October 1989. Current activities in the area of the promotion of research, observation/monitoring and the development of technologies related to global environmental problems are being carried out in accordance with the basic policies contained in this document. Specifically, a "Comprehensive Plan for the Promotion of Research for the Conservation of the Global Environment" is drafted at the beginning of every fiscal year to identify issues of special importance and to follow up on the progress made in the implementation of current plans.

The Prime Minister made a decision concerning long-range planning in August 1990 in response to the recommendations of the Prime Minister's Council for Science and Technology entitled "Basic Plan for Research and Development on Earth Science and Technology" which sets forth the basic approach to the promotion of research and development of earth sciences and technologies over a ten year period. This Basic Plan also identifies important themes in research and development and indicates the role to be played by the government and the measures to be taken in related fields.

In fiscal 1990, a system for the "Global Environmental Research Program Budget" was established in order to integrate and to supplement the various forms of research being carried out for the conservation of the global environment. This Budget was allocated to the Environmental Agency in its entirety and is distributed to various national research institutions in accordance with the "Comprehensive Promotion Program for Global Environmental Research, Monitoring and Technology Development." Disbursements during fiscal 1994 amounted to \2.3 billion.

Furthermore, the "Budget for the Coordination of the Promotion of Science and Technology" which is allocated in its entirety to the Science and Technology Agency is also being used to fund related studies and research.

Table 7-1, 7-2, 7-3, and 7-4 list research projects and, in some cases, indicate the budget under which the research was conducted.

<Policies and Measures in Detail>

7-1. Scientific Research and Survey

Measures are being taken to promote joint research and the exchange of information with foreign research institutions in order to cooperate with the activities of the Intergovernmental Panel on Climate Change (IPCC), and with an aim to participate, cooperate and to bear an appropriate share of the burden of research in such international programs for research in the global environment as the World Climate Research Program (WCRP) and the International Geosphere-Biosphere Program (IGBP).

In particular, measures are being taken to promote research focusing on the Asian-Pacific region with the cooperation of the researchers in the region. Based on these cooperative efforts, progress is being made in creating an Asian-Pacific regional network for research on global changes.

In order to promote oceanographic research as related to global environmental problems, the Deliberative Council on Marine Development submitted its recommendations entitled

"Measures for the Promotion of Japan's Oceanographic Research" to the Prime Minister in December 1993.

7-1-1. Mechanism Understanding and Future Prediction

* The research undertaken in this field since fiscal 1991 which marked the beginning of the Action Program for Arresting Global Warming is as follows.

Table 7-1 Mechanism Understanding and Future Prediction

Subject of Research	Ministry/Agency	Budget	Period
[1] Research on Understanding the Mechanism of Global Warming and Improvement of Predictive Technologies			
a. Research on the Effects of Clouds on Global Warming			
¥ Japanese Cloud and Climate Study	STA	167	1991-2000
b. Research on the Effects of the Oceans on Global Warming			
¥ Joint Research Program for the Western Pacific Region (WESTPAC)	MOT	17	1983-
¥ Projects of the Intergovernmental Oceanographic Commission (IOC)	MOE	4	1981-
¥ International Joint Research for Global Oceans Observation System (GOOS)	MOE	90	1993-1997
¥ Comprehensive Observation and Research of the Northern Pacific and Arctic Ocean Regions	STA	151	1991-
¥ International Joint Research on the General Circulation of the Ocean and a Comprehensive Observation System	STA	**	1990-1994
¥ Research on the Development of Uses of the Kuroshio Current	STA	129	1977-1999
¥ Research on Systemization of Marine Observation	STA	167	1986-
¥ International Joint Research on the Mechanism of Material Circulation in Coastal Waters	STA	**	1992-1994
¥ Research on the Deep Seas	STA	6,463	1977-
¥ Research on the Circulation of Carbon in Oceans	MITI	700	1990-1994
¥ Research on the Circulation and Fixation of Carbon in Oceans	EA and MITI	42	1990-1992
¥ Research on the Mechanism of the El Ni– *ño* Southern Oscillation and Its Effects	STA	45	1994-2003
¥ International Joint Research on Energy and Material Flux in Ocean Ridges	STA	**	1993-1995
c. Research on the Effects of Snow and Ice on Global Warming			
¥ Joint Research on the Global Environment of the Arctic Region	MOE	103	1990-1994
¥ Research on Observation of the Antarctic Region	MOE	3,718	1956-
¥ International Co-operative Study on Observation of Variabilities in the Arctic Atmosphere, Hydrosphere and Biosphere and Interactions among them	STA	**	1990-1994
¥ Impacts of Global Change on Siberia and Resulting Feedback Effects	EA and MAFF	*	1991-
d. Research on the Effects of the Ecosystem on Global Warming			
¥ Projects of the Man and Biosphere (MAB) Program	MOE	1	1983-
¥ Research on the Carbon Cycle in the Terrestrial Ecosystem	EA and MAFF	30	1990-1992
¥ Research Programme on the Change of Tropical Forests and Their Influences	STA	119	1990-1999
¥ Study on the Carbon Cycle in Oceanic and Terrestrial Ecosystems	EA, MAFF, MITI and MOT	*	1993-1995
e. Research on Ancient Climates and Miscellaneous Subjects			
¥ International Geosphere-Biosphere Program (IGBP)	MOE	107	1992-1996
¥ Japan-China Joint Study on Desertification	STA	**	1989-1994
[2] Research on the Improvement of Climate Models			
¥ International Joint Research Program on Solar and Terrestrial System Energy (STEP)	MOE	168	1991-1995
¥ Sino-Japanese Cooperational Programme on the Atmosphere-Land Interaction at Heife River Basin (HEIFE)	MOE	17	1989-1993
¥ Study on the Prediction of Global Warming	MOT	21	1991-1995
¥ Study on the Estimation of Climate Change with a Climate Model	EA, MITI and MOT	*	1991-
¥ Research on the Precision Evaluation of Methane and Nitrous Oxide and other gases on the Greenhouse Effect	MOT	4	1990-1992
¥ Research on Mechanisms and Effects of Climate Changes Resulting from Global Warming	STA	65	1990-1999

[3] Research on the Generation and Absorption of Greenhouse Gases			
¥ Survey for Cataloging of Greenhouse Gases	EA	20	1992-
¥ Research and Observation of the Global Movement and Effects of Materials Responsible for Global Warming	STA	165	1990-1999
¥ Research on the Emission Sources and Emission Volumes of Methane and Nitrogen Oxides	EA, the MOW, MAFF, MITI, MOT and MOC	*	1990-1994
¥ Research on the Structure and Trends in the Temporal and Spatial Changes in Concentration of Greenhouse Gases	EA and the MITI	51	1990-1992
¥ Research on Atmospheric Chemical Reactions of Greenhouse Gases	EA and the MITI	24	1990-1992
¥ Chemical Reactions in the Troposphere and Their Effects on Global Warming	EA and MITI	*	1993-1995
[3] Research on the Generation and Absorption of Greenhouse Gases			
¥ Survey for Cataloging of Greenhouse Gases	EA	20	1993-
¥ Study on the Greenhouse Gases other than CO2	EA	20	1994-
¥ Japanese Study on the Behaviour of Greenhouse Gases and Aerosols	STA	165	1990-1999
¥ Clarification of the flux sources and magnitude for Methane and Nitrous Oxide	EA, MOW, MAFF, MITI, MOT and MOC	*	1990-1994
¥ Evaluation of Temporal and Spatial Variability of Greenhouse Gases	EA and MITI	51	1990-1992
¥ Clarification of Atmospheric Chemistry of GHGs and Related Compound	EA and MITI	24	1990-1992
¥ Chemistry of the Troposheric Trace Gases Related to Global Warming	EA and MITI	*	1993-1995

Notes:
1 Budget amounts are for fiscal 1994 or the respective final fiscal years.
2 Unit: \ million
3 Single asterisk indicates research conducted under the "Global Environment Research Program Budget." Double asterisk indicates research conducted under the "Special Coordination Funds for Promoting Science and Technology." As of August, individual resea

7-1-2. Assessment of Effects

* The research undertaken in this field since fiscal 1991 which marked the beginning of the Action Program for Arresting Global Warming is as follows.

Table 7-2 Assessment of Effects

Subject of Research	Ministry/Agency	Budget	Period
[1] Research on the Effects of Global Warming on the Ecosystem			
¥ Development of Technologies for the Control of the Factors of Global Environmental Change Using the Agricultural, Forestry and Marine Ecosystems	MAFF	213	1990-1996
¥ Evaluation of the Effects of Global Warming on Plants	EA and MAFF	*	1990-1995
¥ Basic Survey on Climate Change and Pest Populations in East Asia	MAFF	11	1993-1994
[2] Research on the Effects of Global Warming on Human Health			
¥ Evaluation of the Effects and the Risks of Global Warming on Human Health	EA and MOW	*	1990-1995
[3] Research on the Effects of Global Warming on Water Resources			
¥ Projects of the International Hydrology Program (IHP)	MOE	10	1990-
¥ Basic Survey of Effects of Global Climate Change on Water Demand and Supply	NLA	3	1990-1992
¥ Assessment of Effects of Global Warming on the Water Balance	HDA and MOC	*	1990-1995
¥ Survey of the Effects of Rising Sea Levels, Changes in Outflow Characteristics, Acid Rain, Rising Temperatures, Hydrology and Water Quality	MOC and HDA	Undecided	
[4] Research on Social and Economic Effects of Global Warming			
¥ Research on Disaster Prediction in the Global Hydrological Process	STA	77	1991-2000
¥ Research on Assessment of Effects of Global Warming on the Urban Environment and Countermeasures	EA	23	-1992
¥ Study of Industrial and Economic Policies for the Conservation of the Global Environment	EPA	5	1990-1991
¥ Basic-Development-Related Studies for the Sustainable Growth Model in the "Development and Improvement of Econometric Models for Economic Planning"	EPA	3	1992-
[5] Research on the Effects of Global Warming on Coastal Regions			
¥ Survey on the Effects of Rising Sea Levels on the Social and Economic Activities of Waterfront Areas and Related Policies	MOT	10	1990-1995
¥ Clarification of Effects of Sea Level Rise Caused by Global Warming	MITI, MOT, MPT and MOC	*	1990-1995
¥ Basic Survey of Coastal Regions	MOC	69	1972-

Notes:
1 Budget amounts are for fiscal 1994 or the respective final fiscal years.
2 Unit: \ million
3 Single asterisk indicates research conducted under the "Global Environment Research Program Budget." As of August, individual research project allocations for fiscal 1994 have not been determined.

7-1-3. Policy Planning and Its Evaluation

* The research undertaken in this field since fiscal 1991 which marked the beginning of the Action Program for Arresting Global Warming is as follows.

Table 7-3 Policy Planning and Its Evaluation

Subject of Research	Ministry/Agency	Budget	Period
[1] Research on Evaluation Methods for Policies for Global Warming			
¥ Evaluation of the Technological Measures to Cope with Global Warming	EA, MOW, MAFF, MITI and MOC	42	1990-1993
¥ Survey of Methods for Predicting the Emission and Absorption of Global Warming Gases	EA	19	1993-
¥ Survey Study of Assessment Technologies for Policies for Global Warming	EA	5	1991-1992
[2] Research on Creating an Environmental Conservation Oriented Social System			
¥ Systems for the Control and Reduction of CO2 Emissions from the Residential Sector	EA and MOC	39	1991-1994
¥ Research on Strategies for Wide Distribution of Electric Vehicles as a Low CO2 Emission Traffic System	EA, MITI and MOT	53	1991-1993
¥ Evaluation of a Sewage and Waste Disposal System for Limiting Global Warming	EA, MOC and MITI	*	1992-1994
¥ Promotion of Domestic and International Measures in the Transportation Sector for Conserving the Global Environment	MOT	36	1993
¥ Participation in the Joint Programs of the IEA	STA	2	1993-1995
¥ Survey of Life-Cycle Energy of Household Resources	STA	13	1992-1995
¥ Comprehensive Research on Creating Economic Structural Policies Aimed at Sustainable Development	EPA	19	1993-1995
¥ Survey Study on Use of Telecommunications in Environmental Improvement	MPT	2	1994
[3] Research on Miscellaneous Policy Planning and Evaluation			
¥ Survey of Policies for Greenhouse Gas Emissions of Automobiles, Vessels, Aircraft and Miscellaneous Stationary Sources	EA	94	1990-
¥ Survey for Formulation of Plans for Preservation and Improvement of Carbon Dioxide Absorbers	EA	6	1991-1992
¥ Promotion of Formulation of Policies for Global Warming	EA	6	1991-
¥ Survey for Formulation of Country Programs Based on the Framework Convention on Climate Change	EA	---	1993-
¥ Survey for Formulating Manuals and Other Materials for Promotion of Countermeasures for Global Warming	EA	29	1992-
¥ Survey Study of the Environmental Conservation of Tropical Forests	EA	15	1990-1993
¥ Survey Study of Cattle Breeding Technologies Related to Global Warming	MAFF	4	1991-1994
¥ Programs for the Establishment of Technologies for Improvement of the Environmental Conservation Functions of the Soil and Fertilizer Application Management	MAFF	163	1991-1994
¥ Project for Experimental Introduction of Efficiency-Controlled Fertilizer	MAFF	37	1991-1994
¥ Program for Contracting of Survey Work for the Establishment of Technologies for Improvement of the Environmental Conservation Functions of Agricultural Production	MAFF	7	1991-1994
¥ Survey Study of Policies for Global Warming (Rising Sea Levels)	MAFF	2	1990-1996
¥ Survey of Measures for the Reduction of the Carbon Dioxide Emissions of Cars and the Establishment of New Fuel Efficiency Standards for Conservation of the Global Environment	MOT	7	1991-1994
¥ Planning and Coordination of Climate Programs	MOT	11	Continuous
¥ Survey Study of Policies for the Promotion of Energy Policies in the Transportation Sector	MOT	16	1990-1991
¥ Effects of Disturbances in Air Currents in Working Room on the Hood Intake Current	MOL	16	1991-1993
¥ Survey Study of Global Environmental Problems	MOC	12	1993-1995
¥ Survey Study on the Utilization of Unexploited Energy Sources	MOC	4	1991-1992
¥ Survey on the Utilization of Sewerage Resources and Energy	MOC	---	1982-
¥ Survey Study on the Promotion of Regional Energy Programs	MHA	3	1992
¥ Research on Global Warming Prevention Effect Caused by Road Traffic Smoothing Plan	NPA	8	1991-1993
¥ Research to Develop New Methods of Urban Traffic Control	NPA	8	1994-1996
¥ Evaluation of Technologies of the Construction Industry for Arresting Global Warming	MOC	---	1994-1996

Notes:

1 Budget amounts are for fiscal 1994 or the respective final fiscal years.

2 Unit: \ million

3 Single asterisk indicates research conducted under the "Global Environment Research Program Budget." As of August, individual research project allocations for fiscal 1994 have not been determined.

7-1-4. Comprehensive Studies on Global Warming With Special Reference to the Asian-Pacific Region

* The research undertaken in this field since fiscal 1991 which marked the beginning of the Action Program for Arresting Global Warming is as follows.

Table 7-4 Comprehensive Studies on Global Warming With Special Reference to the Asian-Pacific Region

Subject of Research	Ministry/Agency	Budget	Period
¥ Research on Global Environmental Changes Centering Around the Asian-Pacific Region	MOE	270	1990-1994
¥ Joint Research on the Global Environmental Conditions of the Asian-Pacific Region	MOE	5	1992
¥ Development of the Asian-Pacific Integrated Model (AIM) to Evaluate Policy Options for Stabilizing Global Climate	EA and MAFF	*	1991-
¥ Research on the Mechanism of Asian Monsoons	STA	155	1989-1998

Notes:
1 Budget amounts are for fiscal 1994 or the respective final fiscal years.
2 Unit: \ million
3 Single asterisk indicates research conducted under the "Global Environment Research Program Budget." As of August, individual research project allocations for fiscal 1994 have not been determined.

7-2. Observation/Monitoring

The basic approach to the promotion of observation/ monitoring related to the global environment is as follows.

* To participate, cooperate and to bear an appropriate share of the burden of research in such international programs for observation/monitoring as the Global Environmental Monitoring System (GEMS), the Global Atmospheric Watch Plan (GAW), the Global Climate Observation System (GCOS), the Global Oceans Observation System (GOOS) and the Integrated Global Oceans Service System (ICOSS) in order to undertake observation/monitoring over large regions, and to contribute to the creation of a network for the Asian-Pacific region.

* In the area of satellite observations of the earth, it is understood that the promotion of global-scale studies is highly important. For this reason, Japan will actively participate in the activities of Committee for Earth Observation Satellites (CEOS), and will promote the development, launching, management and distribution of data which is sufficiently compatible with these programs.

Based on these positions, the implementation of observation/monitoring and the development of related methods, and the distribution of data will be undertaken as follows. For the observation of the concentration of greenhouse gases, observation posts have been established on Hashoma Island in Okinawa Prefecture and at Cape Rakuseki in Hokkaido. Furthermore, a standard observation post for GAW's Background Atmospheric Pollution Monitoring Network (BAPMON) has been established on Minami Torijima Island in the Tokyo Metropolitan Area and a regional observation post has been established at Sanriku-cho in Iwate Prefecture.

7-2-1. Implementation of Observation/Monitoring

Observation/monitoring is being continually improved to gain a better understanding of the temporal and spatial distribution of greenhouse gases in the ocean waters and marine atmosphere, such as carbon dioxide, methane, fluorocarbons, nitrogen oxides, and tropospheric ozone. Furthermore, continuous observations are being made at observation points throughout Japan in order to gain a better understanding of changes in sea level resulting from global warming.

The observation/monitoring undertaken in this field since fiscal 1991 which marked the beginning of the Action Program for Arresting Global Warming is as follows.

Table 7-5 Implementation of Observation/Monitoring

Subject of Research	Ministry/Agency	Budget	Period
[1] Understanding the Phenomenon of Global Warming			
¥ Promotion of Geostationary Meteorological Satellite Program	MOT	5,546	1972-
¥ Polar Orbiting Meteorological Satellite Data Utilization	MOT	109	1972 -
¥ Surface Meteorological Observations (temperature, barometric pressure, wind, precipitation, etc.)	MOT	172	1887-
¥ Upper Air Observations	MOT	752	1938-
¥ Solar Radiation Observations	MOT	17	1932-
¥ Meteorological Rocket Observations	MOT	236	1970-
[2] Observation/Monitoring for Understanding the Temporal and Spatial Distributions of			
¥ Greenhouse Gases			
¥ Background Air Pollution Observations	MOT	75	1974-
¥ Observation for Monitoring Background Marine Pollution	MOT	34	1972-
[3] Observations of Rising Sea Levels Resulting from Global Warming			
¥ Standard Surveying Studies of the Oceans	MOC	14	1984-
¥ Tidal Observation/Monitoring	MOT	89	Continuing
¥ Observation/Monitoring of Changes in Sea Levels (Very Long Baseline Surveying and Tidal Observation)	MOC	6	1992-

Notes:
1 Budget amounts are for fiscal 1994 or the respective final fiscal years.
2 Unit: \ million

3 Single asterisk indicates research conducted under the "Global Environmental Research Program Budget." Double asterisk indicates research conducted under the "Budget for the Coordination of the Promotion of Science and Technology." As of August, individ

7-2-2. Development of Observation/Monitoring Methods

The development of observation/monitoring methods undertaken in this field since fiscal 1991 which marked the beginning of the Action Program for Arresting Global Warming is as follows.

Table 7-6 Development of Observation/Monitoring Methods

Subject of Research	Ministry/Agency	Budget	Period
[1] Research on Development and Use of Satellites			
¥ Development of Sensor Systems for Greenhouse Gases	MITI	1,727	1989-
¥ Research and Development of Multi-Purpose Satellite Systems in the Transportation Field	MOT	32	1988-1995
¥ Research on Space-Based Precipitation Observation Using Dual Frequency Doppler Radars	MPT	78	1988-2000
¥ Development of Earth Observation Platform Scientific Satellites	STA	18,352	1990-1995
¥ Research and Development of Observation Satellite for Tropical Precipitation	STA	2,537	1990-1997
¥ Research on Remote Sensing Technologies for the Global Environment	STA	101	1976-
¥ Earth Observation Plan and Its Implementation Costs	STA	6,191	
¥ Comprehensive Promotion of the Use of Earth Observation Data	STA	18	1978-
¥ Research on the Development of Data Base for Satellite Data Analysis Methods	STA	26	1990-1996
¥ Development of Basic Technologies for the Improvement of Remote Sensing Systems Using Microwave Sensor Data	STA	**	1992-1994
[2] Development of Technologies for Observation of the Sun, Upper Atmosphere and Middle Atmosphere			
¥ International Joint Research on the Advanced Use of Electromagnetic Waves in Global Environment	MPT	173	1992-2002
¥ Research on the Use of Electromagnetic Waves Which Have Short Wavelength in Millimeter Band in Global Environment Measurement Technologies	MPT	43	1990-2000
¥ Research and Development of Space-Weather Forecasting	MPT	73	1988-2002
¥ Research and Development of Global Environment Measuring Technologies Using Active Sensors in the Optical Range	MPT	20	1991-2000
¥ Research on Global Environment Measuring and Forecasting Technologies Using High Definition Three-Dimensional Microwave Imaging Radars	MPT	100	1993-2000
¥ Increased Observations During the STEP Program	MPT	9	1992-1995
[3] Development of Observation Technologies for Marine Changes			
¥ Research and Development of Observation Technologies for Marine Changes	STA	562	1976-
¥ Research on Position Observations at Tide Observation Points Using VLBI and GPS	MOC	19	1990-1995
¥ Research on Development of Large-Scale Marine Observation and Research Vessel	STA	1,926	1994-
¥ Basic Research and Development of Innovative Buoy System for a Global Ocean Observation System	STA	Undecided	1993-1995
[4] Implementation of Global Environment Monitorings			
¥ Monitoring System for Research on the Global Environment	EA	231	1990-
¥ Research and Development of Global Environment Measuring Technologies Using Active Sensors in the Optical Range	MPT	20	1991-2000
¥ Research on Global Environment Measuring and Forecasting Technologies Using High Definition Three-Dimensional Microwave Imaging Radars	MPT	100	1993-2000
¥ Increased Observations During the STEP Program	MPT	9	1992-1995
[3] Development of Observation Technologies for Marine Changes			
¥ Research and Development of Observation Technologies for Marine Changes	STA	562	1976-
¥ Research on Development of Large-Scale Marine Observation and Research Vessel	STA	1,926	1994-
¥ Basic Research and Development of Innovative Buoy System for a Global Ocean Observing System	STA	**	1993-1995
[4] Implementation of Global Environment Monitorings			
¥ Global Environmental Monitoring Program of Center for Global Environmental Research	EA	231	1990-

Notes:
1 Budget amounts are for fiscal 1994 or the respective final fiscal years.
2 Unit: \ million
3 Double asterisk indicates research conducted under the "Special Coordination Funds for Promoting Science and Technology." As of August, individual research project allocations for fiscal 1994 have not been determined.

7-2-3. Dissemination of Observation/Monitoring Data

The measures taken in relation to observation/monitoring data in this field since fiscal 1991 which marked the beginning of the Action Program for Arresting Global Warming is as follows.

Table 7-7 Dissemination of Observation/Monitoring Data

Subject of Research	Ministry/Agency	Budget	Period
[1] Networking and Data Base Making for Earth Observation			
¥ Networking of Earth Observation Data from Satellites	STA	862	1986-
¥ Compilation of Directory of Global Environment Research Information	STA	69	1990-
¥ Research and Development on Creation of Network and Data Base for Satellite Information	MITI	22	1993-
¥ Cooperation for Climate Change Monitoring and Research Network in Asian and the Pacific Region (CLIMONET)	MOT	19	1993-1995
¥ Data Management for Marine Climatology	MOT	8	Continuing
[2] Development of Technologies for Measurement and Information Networks			
¥ Research and Development on Measurement and Information Networks for Global Environmental Observation	MPT	16	1991-1997
¥ Study of Development of Uses of Radio Waves and Information Communications for the Conservation of the Global Environment	MPT	2	1991-1996
[2] Technological Development of Geographic Information Systems			
¥ Research on Global Geographical Data Development for Global Environment Studies	MOC	16	1993-1995
¥ Study of Developing International Geographic Information for Global Environment	MOC	16	1993-1995
[4] Provision of Data by Centers			
¥ Center for Global Environmental Research	EA	44	1990-
¥ Management of the Japan Marine Data Center	MOT	146	1965-
¥ Japan Climatic Data Centre (JCDC) Activities	MOT	26	1990-

Notes:
1 Budget amounts are for fiscal 1994 or the respective final fiscal years.
2 Unit: \ million

7-3. Technologies for Adaptation to Global Warming

The development of measures and technologies for adapting to global warming has just recently begun. At the present time, a few research projects have been started with the aim of promoting the development of appropriate measures and technologies.

* A seven-year research project for the analysis of rice genomes was started in fiscal 1991 with an aim to undertake basic research in the application of gene-recombination technologies to the field to agriculture. The use of gene-recombination technologies in agriculture and fisheries will contribute to the creation of new strains which can adopt to the environmental changes resulting from changes in temperature, sunlight and precipitation triggered by global warming.
* A six-year plan was started in fiscal 1990 for the study of the effects of rising sea levels on barrier islands. This project will also study conservation engineering using physical models and quantitative analysis.
* Furthermore, as mentioned above in the section on Research and Survey, research is being undertaken on the evaluation of the effects of global warming on the ecosystem, human health, water resources, socio-economic activities, and coastal regions. The results gained from these studies will be used as basic reference data in the following areas: adaptation to changes in precipitation

patterns through the development of technologies for flood control and development of water resources; conservation of coastal regions and rivers, and urban redevelopment to counter rising sea levels; and, development of conservation technologies for the protection of vegetation and wild life to counter global climate changes.

8. Promotion of International Cooperation (Including Financial and Technical Assistance)

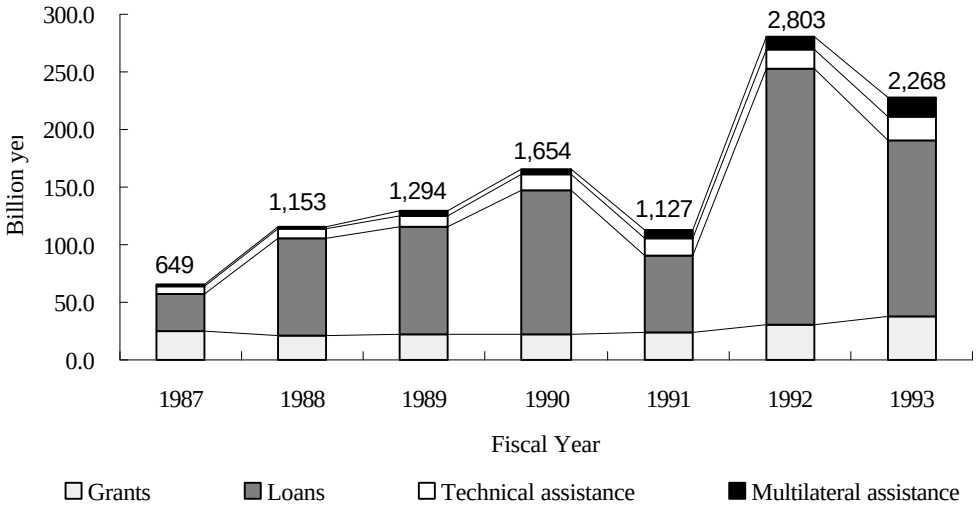
<The Approach of Policies and Measures>

With regard to international cooperation for the conservation of the global environment, the Council of Ministers for Global Environmental Conservation reached agreement on the following basic policies in June 1986: to increase official development assistance (ODA) for environmental needs; to cooperate with the developing countries in the development of technologies which suit the needs of these countries, and to promote the transfer of technologies and the development of human resources in environmental fields; and, to take environmental impact into consideration when implementing ODA programs. Following this agreement, the related ministries, agencies and organizations have been cooperating to promote the overall increase of environment-related ODA disbursements and to raise the awareness of the environmental impact of ODA programs.

In addressing the United Nations Conference on Environment and Development held in June 1992, the Prime Minister announced that Japan would endeavor to significantly increase and upgrade its environment-related ODA and that it would aim to raise its total disbursements in the five-year period beginning in fiscal 1992 to \900 billion - \1 trillion. In fiscal 1992 and 1993, just the first two years of this period, Japan disbursed over half of that five-year figure. At the same time, the Cabinet gave its approval to "Japan's Official Development Assistance Charter" which spells out the philosophy and principles of Japan's official development assistance. This document identifies environmental conservation as one of the basic purposes of ODA and states that "the compatibility of environment and development" must be one of the basic principles of ODA. Furthermore, it states that efforts will be made to achieve sustainable development on a global scale by assisting the self-helping efforts of the developing countries.

The "Environmental Basic Law" stipulates that the government must endeavor to take the necessary measures for promoting international cooperation for the conservation of the global environment.

Figure 8-1 Disbursements of Environment-Related ODA (by type of aid)



<Policies and Measures in Detail>

8-1. Comprehensive Support for Arresting Global Warming

* Japan has contributed $34,330,000 to the Global Environment Facility (GEF) Core Fund as of the end of April 1993.

* Japan contributes $50,000 per year in support of the activities of the IPCC. Japan participates as a bureau member and lead author in compiling IPCC reports. It has also hosted workshops and made human resource and financial contributions.

* Japan has organized the Asian-Pacific Regional Seminar on Global Warming as a forum of discussion of global warming issues and countermeasures for the Asian-Pacific Region. This seminar has been held on three occasions (in Nagoya in January 1990, in Bangkok in March 1993, and in Osaka in March 1993) with the countries, government officials and experts of this region, as well as international organizations in attendance. During the Third Seminar, the dissemination of the guideline for the cataloging of greenhouse gas emissions and absorption which was developed by the IPCC/OECD was considered, and Asian-Pacific strategies for arresting global warming were examined.

  Furthermore, Japan is conducting research in the Asian-Pacific region on the effects of global warming, the emission of greenhouse gases, and the identification of priority policies and is also undertaking to support the developing countries of this region in creating individual national strategies for counteracting global warming. In the past, Japan has undertaken such programs in Indonesia, Fuji and Western Samoa.

* Beginning in 1992, the Japan International Assistance Agency (JICA) has hosted

seminars for the administrative officers of the Asian-Pacific region for the promotion of a scientific understanding of global warming and related policies and countermeasures.

* Japan has been involved in the transfer of technologies and the provision of equipment to the meteorological organizations of developing countries participating in the international programs for global meteorological monitoring and global climate program of the World Meteorological Organization (WMO).

8-2. Promotion of Technology Transfer for Arresting Global Warming

8-2-1. Transfer of Technologies for Energy Conservation

* In order to develop effective responses to global warming and to support the self-helping efforts of the developing countries in the areas of energy and environment-related problems through technical assistance in the fields of energy conservation and new energy sources, Japan is implementing a "Green Aid Plan" which effectively combines the policy tools of cooperation assistance in research and human resource development. In addition, Japan is conducting technical cooperation programs through JICA.

* Furthermore, Japan is involved in the following programs: research on the transfer of traffic control technologies with an aim to alleviating traffic congestion in developing countries; field study of nitrogen dioxide generation by fertilizers with an aim to controlling such generation of nitrogen dioxide; demonstrating and disseminating fertilizer application methods; and, the provision of information of developing regions by the Japan Environment Corporation.

* Under the GEF framework, the Overseas Economic Cooperation Fund (OECF) is cooperating with the World Bank to provide financing to promote demand-side energy conservation through the development, production, and spread of energy-saving equipment.

8-2-2. Information Centers for Environmental Conservation Technologies

* Regarding the creation of centers for technology transfer, the UNEP International Environmental Technology Centre was established in Japan in October 1992. The Center functions to develop data bases for environmental conservation technologies, to provide information and to undertake training and consulting services. (This Center will be based in Osaka and Shiga Prefecture. The facilities in Osaka have been in operation since April 1994. The Shiga facilities are now under construction.)

* Japanese grants of approximately \10 billion are being used to establish the Japan-China Friendship Environmental Protection Center (to be completed by the end of fiscal 1995). Parallel to this, Japan has undertaken a three-year project-type technical cooperation program which began in 1992. Similar cooperation assistance programs are currently being conducted in Thailand and Indonesia.

8-3. Support to Conservation and Development of Tropical Forests and Other Sinks for Carbon Dioxide

8-3-1. Supporting the ITTO and TFAP

* Japan is currently the largest contributor of funds to the ITTO among all member countries and is actively participating in promoting ITTO programs. During 1992, Japan provided \1,468 million in voluntary contributions, in addition to its annual allotment of \79 million. Furthermore, Japan is involved in the monitoring of the exports and imports of tropical timber collecting data on imports by the leading Japanese trading companies.
* Japan supports the activities of the FAO by making annual contributions. Between fiscal 1988 and fiscal 1990, Japan annually disbursed a sum of $394,000 in trust funds to despatch experts and to provide other forms of assistance to countries which had initiated National Tropical Forestry Action Plans. Furthermore, Japan is participating in the ongoing efforts for the reorganization of TFAP (ad hoc meeting) and has made annual contributions of $349,000 between fiscal 1991 and fiscal 1993 to the field project for formulating an emergency plan for afforestation. In fiscal 1992, Japan contributed $100,000 to the FAO project for Information Support for the TFAP.

8-3-2. Support to Sustainable Forestry Management, Afforestation and Conservation of the Ecosystem

* In the area of forestry-related cooperation assistance, Japan has provided loans to India, Indonesia, and other nations to finance afforestation projects, totaling about 600,000 ha in area and has provided grants for the building of centers for promoting the afforestation activities of resident populations. As of April 1994, Japan is undertaking project-type technical cooperation programs combining the despatch of experts, the acceptance of trainees and the provision of equipment and materials in a total of 13 countries.
* Beginning in 1990, Japan undertook a three-year project throughout South America for basic research on the systematic development of technologies needed for the conservation and afforestation of mangrove forests. Also in 1990,

Japan initiated a five-year project in Costa Rica, Peru and Thailand for creating a manual for afforestation technologies for mahogany, dipterocarps and other marketable tropical trees, and is conducting a study of seed characteristics needed for large-scale afforestation. In a related development, a five-year project was started in 1991 in Indonesia and Malaysia for the study of the establishment of appropriate forestry facilities for the sustainable use of tropical forests. A study was initiated in 1993 for augmenting the natural restorative potential of forests without relying on tree planting programs by focusing on the siting of such secondary forest facilities as protective tree zones and firebreak zones.

* A study was begun in 1992 of afforestation technology policies and model afforestation planning from the perspective of the carbon dioxide fixing capacity of forests. A test site has been chosen in Indonesia, and evaluations are being made in Thailand and Malaysia of the carbon dioxide absorption potential of natural forest growth.
* Since 1990, a series of empirical studies concerning the causes of the diminishment of tropical forests and their conservation are being conducted in Indonesia, Malaysia and Thailand for the collection and analysis of basic data on regional characteristics, such as farm management and land use.
* In the area of creating information networks, Japan hosted the Conference on Senior Foresters in July 1991 in Yokohama in cooperation with the ITTO and with the participation of 42 countries and 12 international organizations. Following this up, Japan hosted the Conference of Senior Foresters for Conservation and Sustainable Management of Tropical Forests during which specific action programs were examined for "sustainable forestry management," "environmental afforestation," and "the preservation of species."
* In the area of human resource development and the support of citizens' activities in the conservation of tropical forests, the Japan International Forestry Promotion and Cooperation Center has been established as activities center for the promotion of international greenery projects. With an annual budget of approximately \200 million, the Center has been strengthening the organizational foundations and has been involved in training programs since 1991.
* In the area of monitoring the conservation of tropical forests, the Tropical Forest Information Center was established in 1990 with an annual budget of approximately \300 million. The Center is involved in the analysis of satellite information of remote sensing of forestry resources and is developing a system for the delivery of images to TV monitors. In the past, it has implemented programs in Thailand and Indonesia. The Center also studies the damage

caused to tropical forests by fires and has used this information to develop remote sensing technologies for formulating forest restoration plans. In the past, such a study was conducted for the mountain fires in Kalimantan in Indonesia.

8-3-3. Prevention of Acid Rain

* Japan is hosting annual expert meetings on acid precipitation monitoring networks in East Asia over a three-year period beginning in fiscal 1993. In addition, the acid rain-related problems have been made a principal issue for discussion in the Northeast Asian Conference on Environmental Cooperation.
* In the area of acid-rain damage to the forests of developing countries, Japan is undertaking a five-year project for information gathering, research on monitoring and studies of actual damage to the coastal regions of developing countries. Studies are also being conducted on the establishment and implementation of policies to counter acid-rain damage. In the past, damage information has been collected in Indonesia and Malaysia, while studies are currently in progress in United Arab Emirates and Qatar.
* During fiscal 1993, Japan provided loans totaling approximately \16 billion for the installation of flue gas desulfurization equipment in a Thai power generation plant. Since 1990, Japan has been working jointly with Indonesia for the development of a simplified desulfurization unit for coal boilers. The results of this project will be used in other regions.

8-3-4. Prevention of Desertification

* Japan was an active participant in the Inter-Governmental Committee for the drafting the International Convention to Combat Desertification which was adopted in June 1994. At the present time, Japan is involved in the following studies: research on the evaluation of the interaction between desertification and human activities in western India and eastern China; international joint research on the mechanism of desertification in the areas surrounding the Takla Makan Desert in China; Sino-Japanese joint survey concerning reforestation technologies in desertified areas and model afforestation; Sino-Japanese joint research on the interaction of the topsoil and atmosphere in the Heife River basin; and empirical study of desertification prevention technologies in the Saharan Sahel. In addition, Japan is involved in a joint research and development project with Egypt for soil improvement and the development of water retaining agents using highly-absorbent resins. In the African region, Japan is implementing a cooperative project for greenery promotion aimed at providing technical guidance for afforestation to farmers and promoting agro-

forestry.

8-4. Promotion of Cooperation in Research and the Development of Appropriate Technology

8-4-1. Cooperating With Research Activities of the Developed Countries

* In the area of research on the preservation of the global environment, it is necessary to undertake research in cooperation with such international research programs for global environment preservation as the International Geosphere-Biosphere Program (IGBP) and World Climate Research Program (WCRP). Japan is involved in research in these areas as described under "7. Scientific Research, Observation, and Monitoring."
* In January 1994, Japan hosted the Second Workshop of the Asia-Pacific Network for Global Change Research (APN) in which the countries of the Asian-Pacific region cooperate to promote research on global changes. In the course of the Second Workshop, two working groups were established for creating networks and it was decided that the temporary secretariat of the APN would be placed in Japan. Furthermore, efforts were made for promoting and upgrading the research programs in the field of global environmental sciences in universities and other institutions.
* In the area of the development of global environment and energy technologies, the Ad Hoc Working Group Meeting for International Cooperation in the Development of Environment and Energy Technologies was held in Tokyo in October 1993 with the participation of the OECD/IEA, the G7 countries, Holland and the representative of the European Community. Agreement was reached in the meeting on the importance of the role of technology, the importance of international cooperation in the promotion of the efficient development of environment and energy technologies by national governments, and the importance of a strategic approach to international research in the field of environment and energy technology development.

8-4-2. Development of Appropriate Technology for Developing Countries

* In response to requests from the governments of developing countries, Japan despatches study groups for formulating development programs for energy conservation and solar power generating systems based on the assessment of the country's future economic growth, and current technology levels and environmental policies.
* Beginning in 1993, Japan has been undertaking joint research on global environment measurement technologies with Asian researchers in the field of

electromagnetics for the purpose of coping with the environmental problems of developing countries. Currently, Japan is conducting a research project in Indonesia on the use of laser radars for measurement of urban air pollutants, such as the concentration of carbon dioxide, and is also developing an environmental network for data processing.

8-5. Promotion of International Cooperation in the Private Sectors

Many of the existing environmental conservation technologies were developed by private companies. Parallel to this, foreign direct investments in developing countries play a highly significant role in technology transfer. In addition, Japan's various domestic non-governmental organizations (NGO) are playing an active part in the implementation of environmental conservation projects and the hosting of symposiums and seminars.

* Private companies are beginning to participate in natural conservation swaps for the protection of forests and other natural resources. To lend support to these efforts, a guideline for the appropriate implementation of natural conservation swaps was formulated during fiscal 1993.
* These private sector activities, described under "6. Promotion of Public Awareness," have received financial support from the following sources: the Ministry of Foreign Affair's Subsidy System for NGO Projects and Small Scale Grant Assistance; aid disbursements by the Ministry of Posts and Telecommunications from its postcards with contributions and its International Volunteer Deposit System; and, the Japan Environment Corporation's assistance to private organizations from its Global Environment Fund. It is expected that these types of activities will continue to expand as a result of growing public interest.

8-6. Considerations in Undertaking International Cooperation Projects

* In 1989, the Council of Ministers for Global Environment Conservation agreed that special consideration must be given to environmental factors in the implementation of ODA projects.
* Beginning in 1990, JICA which is in charge of technical cooperation began to formulate environmental guidelines for specific fields of international cooperation, such as the "Environmental Guidelines for Social and Economic Infrastructure Development Projects." Based on the OECF Environmental Guidelines established in October 1989 [CHECK], the Overseas Economic Cooperation Fund, which is in charge of yen-denominated loans, has been endeavoring to maintain standards of environmental consideration in its cooperation projects.

* It is highly important for private companies to give due consideration to environmental factors when investing abroad. In accordance with the 1989 agreement of the Council of Ministers for Global Environment Conservation, the government of Japan is endeavoring to ensure that private companies investing abroad will give due consideration to environmental factors.

In addition, the government has issued its "Corporate Behavior Expected of Companies Investing Abroad" and is encouraging private companies to follow these suggestions.

Economic organizations are independently issuing their own policy statements regarding global environmental issues and are proceeding with it own independent programs.

8-7. Joint Implementation

Joint implementation is aimed at bringing together the technologies, know-how and financial resources of individual countries to work in cooperation to arrest global warming, to reduce the emission and promote the removal of greenhouse gases on a global scale, and to develop more efficient methods for reduction by introducing technologies with lower overall costs. It is believed that joint implementation offers many important advantages in the pursuit of these aims.

From this perspective, in order to promote the advancement of joint implementation as stipulated under Section 4-2 of the Convention, Japan is contributing to international efforts for clarifying the concept of joint implementation.

The specific details of joint implementation contain many matters requiring further consideration. For instance, methods for the allocation of emission reduction targets among countries participating in joint implementation (including cases in which reduction is implemented by the private sector) must be carefully examined. Developing countries and others have also voiced the concern that joint implementation may be used by the advanced industrialized countries to avoid meeting their obligations.

Against this background, the basic stance to be taken in connection with joint implementation should be one that does not undermine the intent, purpose and viability of the Convention. On this basis, Japan is planning to undertake preparations for the implementation of a model project to contribute to the formulation of criteria for joint implementation while giving due consideration to the pursuit of efficient solutions to the problems of global warming and taking appropriate measures to avoid any misunderstanding that joint implementation may in any way undermine the performance of the obligations of the advanced nations under the Convention.

References:

Annual Report on the National Land, National Land Agency

Annual Report on Trends in Agriculture, Ministry of Agriculture, Forestry and Fisheries

Annual Report on Trends in Forestry, Ministry of Agriculture, Forestry and Fisheries

Quality of the Environment in Japan, Environmental Agency

Annual Report on the Transportation Economy, Ministry of Transportation

Present Conditions in National Land Construction, Ministry of Construction

White Paper on Welfare, Ministry of Welfare

White Paper on Atomic Energy, Atomic Energy Commission

White Paper on Nuclear Safety, Nuclear Safety Commission

White Paper on Police, National Police Agency

Waste Disposal in Japan, Waste Management Division, the Water Supply and Environmental Sanitation Department, the Environmental Health Bureau, the Ministry of Health

Collected Reports of the Global Environment Research Program Budget, Research and Information Office, Control and Cooperation Division, Global Environment Department, Planning and Coordination Bureau, the Environment Agency

Fourteen Recommendations for the Regeneration of the Earth, Ministry of International Trade and Industry

Energy '93, Ministry of International Trade and Industry

New Sunshine Program Handbook, Ministry of International Trade and Industry

Energy Conservation Handbook, Compiled by the Energy Conservation and Alternative Energy Policy Division of the Agency of Natural Resources and Energy

Handbook on Alternative Energy Sources for Petroleum, Edited by the Agency of Natural Resources and Energy

Analysis of the Labor Economy, Ministry of Labor

Japan's ODA, Ministry of Foreign Affairs

Chapter 4

Projections of Effects of Greenhouse Gas Countermeasures

1. Basic Approach

The effects of greenhouse gas countermeasures are projected on the basis of the Guidelines for the Preparation of First Communications by Annex I Parties.

1-1. Target Year

Because fuel consumption and other important future values are published in fiscal-year (April 1 to March 31) units, the projections discussed here target fiscal 2000 (April 2000 through March 2001).

1-2. Targeted Greenhouse Gases

The effects of emissions-reducing measures are projected for carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). The effects of measures to enhance greenhouse gas sinks are projected for carbon dioxide.

Because of insufficient information, no projections are made in this report concerning other greenhouse gases such as nitrogen oxides (NOx), carbon monoxide (CO), non-methane volatile organic compounds (NMVOCs), PFCs, HFCs, and SF6. Efforts will be made to provide more information concerning these gases as it becomes available.

1-3. Estimating Methods

To project the effects of greenhouse gas countermeasures, emission/removal factors for each source and sink were established as described in the Greenhouse Gas Inventory, and then multiplied by projected fiscal 2000 activity data values, including such factors as the amount of energy supply.

Currently, emission/removal factors and activity data needed to estimate future emissions and removals are not clear in some fields. Improvements will be made as more information is acquired and as international trends in these fields develop.

2. Carbon Dioxide (CO_2) Emissions

2-1. Basic Approach

* Projections concerning the effects of measures to reduce carbon dioxide emissions are made in the following categories. Specifically, these include: 1) energy-conservation and other measures in "Energy (Fuel Combustion)" category; 2) carbon-dioxide emission control measures in "Industrial Processes" category; and 3) measures to reduce municipal waste in the Waste category.
* The "Energy (Fuel Combustion)" category in particular accounts for a large proportion of carbon dioxide emissions. Projection in this category are based on

the energy supply and demand outlook in the "Long-term Energy Supply and Demand Outlook" by the Advisory Committee for Energy. The "Outlook" is the basis of goals for oil-alternative energy supply established in the Law Concerning the Development and Introduction of Oil-Alternative Energy, which was formulated with the aim of helping Japan, a highly oil-dependent nation, to secure a comprehensive energy supply. For this reason, estimates for energy demand in the "Outlook" are made on the assumption that no shortage in energy supply will result as restrictions are placed on carbon dioxide emissions.

Projections in the "Outlook" are made on the basis of certain assumptions concerning the rate of Japan's economic growth and the price of oil(1). The following assumptions are also made as described in Chapter 3, "Policies and Measures": that all energy-conservation measures formulated since fiscal 1990 that contribute to reduce carbon-dioxide emissions are fully implemented, including the implementation of the revised Law Concerning the Rational Use of Energy and the new Energy Conservation and Recycling Assistance Law; and that new energy-conservation measures formulated since fiscal 1994 are also fully implemented by all parties concerned.

(1) Assumed Economic Growth Rate and Oil Price in the "Long-term Energy Supply and Demand Outlook."

(Economic growth rate)

Fiscal 1991--1994: Actual rates (-- 1993) and from the Economic Outlook and Basic Policy Stance (1994)

Fiscal 1995--2000: 3.5% per annum, the rate assumed in the current economic plan ("The Five-Year Economic Plan---Sharing a Better Quality of Life around the Globe" fiscal 1992--1996.) and its exploitations

(Oil Price)

US$20 per barrel in fiscal 2000 (equivalent to current oil price in real term).

* The Japanese government designated its Action Program To Arrest Global Warming as the national plan provided for in the United Nations Framework Convention on Climate Change. The Action Program sets the following two targets, based on the common efforts of the major industrialized countries to limit carbon dioxide emissions.

(1) The emissions of CO_2 should be stabilized on a per capita basis in the year 2000

and beyond at about the same level as in 1990, by steadily implementing a wide range of measures under this Action Program, as they become feasible, through the utmost efforts by both the government and private sectors.

(2) Efforts should also be made, along with the measures above, to stabilize the total amount of CO_2 emission in the year 2000 and beyond at about the same level as in 1990, through progress in the development of innovative technologies, etc., including those related to solar, hydrogen and other new energies as well as fixation of CO_2 at the pace and in the scale greater than currently predicted.

2-2. Projection and Evaluation of Carbon Dioxide Emissions in Fiscal 2000

* Total carbon dioxide emissions in fiscal 2000 resulting from those existing and new energy-conservation measures taken into account in the Long-Term Energy Supply and Demand Outlook are estimated to be about 330 million tons of carbon (Table 4-2-1).
* On a per capita basis, this indicates emissions of about 2.6 tons of carbon per year in fiscal 2000; compared with the level actually calculated in fiscal 1990 (2.59 tons of carbon per year), this means that the first target of the Action Program cited above is estimated to be achievable.
* Yet greater efforts will be necessary, however, to achieve the Action Program's second target of maintaining total carbon dioxide emissions at the 1990 level, since total emissions are estimated to increase with respect to the fiscal 1990 total of 320 million tons of carbon.

Table 4-2-1 Carbon Dioxide Emissions in Fiscal 2000

Category	Emissions
Energy	3.1 * 10^8 tons of carbon (1.1 * 10^6 Gg-CO2)
Industrial Processes	0.1 * 10^8 tons of carbon (0.05 * 10^6 Gg-CO2)
Waste	0.1 * 10^8 tons of carbon (0.05 * 10^6 Gg-CO2)
Total	3.3 * 10^8 tons of carbon (1.2Ë * 10^6 Gg-CO2)

2-3. Projected Effects of Measures

2-3-1. Energy (Fuel Combustion)

* Projections of carbon dioxide emissions from fuel combustion are based on the total amount of primary energy supply cited in the "Long-term Energy Supply and Demand Outlook."
* If all of the energy-conservation measures incorporated in the "Outlook" are fully implemented by all parties concerned, carbon dioxide emissions in fiscal 2000 will be reduced by approximately 30 million tons of carbon (about 120,000 Gg-CO_2), as compared with a scenario in which no measures are implemented. (See

Table 4-2-2.)

This projection was obtained using the same economic growth rate and other factors that are used in the "Outlook." Comparisons were made with trial calculations of final energy consumption for fiscal 2000 based on the assumption that total energy consumption in Japan is allowed to grow as usual.

Table 4-2-2 Energy-conservation Measures and the Effects in Reducing Carbon Dioxide

Sector	Energy-conservation Measures	Carbon Dioxide Reduction
Industry	Based on the law, strengthening energy efficiency standards for businesses aiming at reducing energy-consumption unit requirements by 1% or more per year. Providing low-interest financing and tax incentives to promote the introduction of energy-saving equipment such as waste heat recovery boilers. Developing and disseminating energy-saving technologies such as ceramic gas turbines.	Approximately 10 million tons of carbon
Commercial and Residential	Based on the law, strengthening energy-efficiency standards for building contractors in order to improve building insulation. Providing low-interest and premium financing to encourage the dissemination of energy-saving buildings and residences. Improving the energy consumption efficiency of air conditioners, televisions, and other products by strengthening energy-efficiency standards for manufacturers. Promoting the dissemination of energy-saving appliances and equipment by requiring labels indicating the energy consumption efficiency of individual air conditioners, televisions and other products. Promoting the dissemination of energy-saving appliances and equipment through the use of energy-saving product marks. Developing and disseminating energy-saving technologies such as lightweight insulating materials. Promoting effective regional energy use by subsidizing such business activities as regional heat supply using unutilized energy sources.	Approximately 10 million tons of carbon
Transport	Based on the law, strengthening energy-efficiency standards for manufacturers in order to improve automotive fuel mileage. Improving the efficiency of cargo transport through such measures as selecting the appropriate transportation mode and practicing combined shipping policies. Improving the efficiency of the transportation system and easing traffic congestion by constructing roads and parking lots.	Approximately 10 million tons of carbon

2-3-2. Industrial Processes

* Carbon dioxide emissions from industrial processes are estimated to be about 2 million tons of carbon (about 7,000 Gg-CO_2) less in fiscal 2000 than they were in fiscal 1990. This anticipated decline is attributed to reduction of limestone being burned as part of the cement manufacturing process, and less production activity on the part of steelmakers, although this latter factor is highly uncertain.

2-3-3. Waste

* Projections of carbon dioxide emissions from "Waste" sector are based on estimates of the total amount of waste that will be generated in fiscal 2000. For municipal waste, the 30% reduction target for fiscal 2000 outlined in the Report of the Living Environment Council's Special Committee for Waste Reducing and Recycling was used, based on the assumption that serious efforts will be made to thoroughly recycle paper waste, reduce excessive packaging, and limit

the use of throw-away containers.

* Two municipal-waste scenarios were compared. The first assumes that no waste reduction measures are implemented and that the incineration ratio remains at the current level. The second assumes that municipal waste is reduced by 30% and that the incineration ratio continues to increase in line with past trends. Carbon dioxide emissions would be reduced by some 2 million tons of carbon (about 9,000 Gg-CO_2) in the second senario as compared with the first.
* Japan has actively developed incineration as a means of reducing waste amounts and stabilizing waste disposal. Although this measure curb resulted in increased carbon dioxide emissions, it has also contributed to fewer methane emissions.

2-4. Projected Levels beyond 2000

* Total carbon dioxide emissions are expected to stabilize at the 1990 level beyond the year 2000 through implementation of medium- and long-term measures. Japan intend to maintain measures in step with world opinion to curb carbon dioxide emissions.

3. Carbon Dioxide (CO_2) Removals

3-1. Basic Approach

* Projections are based on the anticipated effect of "managed forests" as a carbon dioxide sink.
* The Japanese government formulates a 15-year-period Nationwide Forest Plan every five years. The plan is formulated in conformity with the Basic Plan Regarding Forest Resources and the Long Range Prospect Regarding Demand and Supply of Forest Products.

  The current plan, which was formulated in August 1991 and covers the period from 1991 to 2007, includes forest management goals and other items related to the improvement of forests. Projections for carbon dioxide removals in 2000 were based on the forest management goals and other items outlined in the plan.
* In addition, the Action Program To Arrest Global Warming sets the following target: "With respect to sinks of CO_2, efforts should be made to work for the conservation and development of forests, greenery in urban areas and so forth in Japan and also to take steps to conserve and expand forests on a global scale, among others."

3-2. Projection and Evaluation of Carbon Dioxide Removals in Fiscal 2000

* With the calculation of removal based on the forest management goals set by the Nationwide Forest Plan cited above, carbon dioxide removals are projected to total about 25 million tons of carbon (about 92,000 Gg-CO_2), in fiscal 2000, representing a slight increase over fiscal 1990 removals. The projection comes from the prospect that forest area is maintained at current levels while progress is made in appropriate forest management efforts.
* Further efforts must be made to strengthen forest management efforts in accordance with the target set in the Action Program.

4. Methane (CH_4) Emissions

4-1. Basic Approach

* Projections concerning the effects of measures to reduce methane emissions are made in the following categories. Specifically, these include: 1) energy-conservation and other measures in the "Energy (Fuel Combustion)" category; and 2) measures to reduce municipal waste in the "Waste" category. Although methane emission control measures are also planned for the "Agriculture" sector and other categories, their effects are not considered here because it is difficult to make quantitative projections at this time.
* The Action Program To Arrest Global Warming also sets the following target: "The emission of methane gas should not exceed present level."

4-2. Projection and Evaluation of Methane Emissions in Fiscal 2000

* Based on the energy conservation measures and municipal-waste reduction measures described above, total methane emissions are estimated to be about 1,150 Gg in fiscal 2000, as shown in Table 4-4-1.
* Because the above amount is less than the 1,380 Gg of methane emitted in fiscal 1990, the target for methane emissions set by the Action Program is estimated to be achievable.

4-3. Projected Effects of Measures

4-3-1. Energy (Fuel Combustion)

* As with carbon dioxide emission projections, methane emission projections for fiscal 2000 are based on the outlook included in the "Long-term Energy Supply and Demand Outlook" by the Advisory Committee for Energy. However,

because methane emissions generated by fuel combustion represents only a small proportion of total emissions, energy conservation measures will not be that effective in reducing overall methane emissions.

Table 4-4-1 Methane Emissions (Fiscal 2000)

Category	Emissions
Energy	1.2 * 10^2 Gg
Agriculture	8.9 * 10^2 Gg
Waste	1.4 * 10^2 Gg
Total	11.5 * 10^2 Gg

4-3-2. Energy (Fugitive Emissions from Coal Mining, Etc.)

* No specific projections are available concerning how much coal will be produced in fiscal 2000, but Japan's coal production has been declining, and the basic direction of future policies will be toward the further phased reduction of domestic coal production.
* For these reasons, projections concerning the amount of coal that will be produced in fiscal 2000 have been based on the latest data concerning coal demand, as shown in the 1994 demand outlook included in the "Implementation Plan for Rationalizing the Coal Mining Industry."
* Based on the above, fugitive methane emissions in fiscal 2000 will be reduced by about 10 Gg as compared with fiscal 1990 because of reductions in the amount of coal that is mined.

4-3-3. Agriculture

* Activity data for fiscal 2000 methane emissions in the "Agriculture" category are based on values cited in the "Long-term Prospects for the Demand and Production of Agricultural Products" approved by the Cabinet in January 1990. Based on the "Agricultural Basic Law," the "Prospects" was formulated with the aim of securing basic domestic food-supply capability while adapting to emerging trends in agricultural product demand and working to maximize productivity.
* Based on the above data, methane emissions from "Agriculture" category in fiscal 2000 will increase by about 100 Gg as compared with fiscal 1990. It should be noted, however, that surveys are currently being conducted on farming methods that will curb the generation of methane, and experimental research is being pursued with regard to fermentation treatment of animal wastes. Because it is difficult at this time to quantitatively project the effects of these efforts, however, they have not been included here.

4-3-4. Waste

* Projections of methane emissions from "Waste" category are based on estimates of the total amount of waste that will be generated in fiscal 2000, and on the targeted dissemination ratio for sewer systems. For municipal waste, the 30% reduction target for fiscal 2000 outlined in the Report of the Living Environment Council's Special Committee for Waste Reducing and Recycling was used, based on the assumption that serious efforts will be made to thoroughly recycle paper waste, reduce excessive packaging, and limit the use of throw-away containers. Another factor that was considered was the fact that Japan has actively developed incineration as a means of reducing waste amounts and stabilizing waste disposal.
* Two municipal-waste scenarios were compared. The first assumes that no waste reduction measures are implemented and that the incineration ratio stays at the current level. The second assumes that municipal waste is reduced by 30% and that the incineration ratio continues to increase in line with past trends. Methane emissions would be reduced by some 470 Gg in the second scenario as compared with the first.

5. Nitrous Oxide (N2O) Emissions

5-1. Basic Approach

* Projections concerning the effects of measures to reduce nitrous oxide emissions are made in the following categories. Specifically, these include: 1) energy-conservation and other measures in the "Energy (Fuel Combustion)" category; and 2) measures to reduce municipal waste in the "Waste" category. Although nitrous oxide emission control measures are also planned for the "Agriculture" sector and other categories, their effects are not considered here because it is difficult to make quantitative projections at this time.
* The Action Program To Arrest Global Warming also sets the following target: "To the extent possible, nitrous oxide and other greenhouse gases should not be increased."

5-2. Projection and Evaluation of Nitrous Oxide Emissions in Fiscal 2000

* Based on the energy conservation measures and municipal-waste reduction measures described above, total nitrous oxide emissions are estimated to be approximately 52 Gg in fiscal 2000, as shown in Table 4-5-1.
* Because the above amount is slightly more than the 48 Gg of nitrous oxide

emissions in fiscal 1990, more work must be done on clarifying emission mechanisms and developing controlling technologies to meet the goal set by the Action Program.

Table 4-5-1 Nitrous Oxide Emissions (Fiscal 2000)

Category	Emissions
Energy	25 Gg
Industry Processes	15 Gg
Agriculture	5 Gg
Waste	7 Gg
Total	52 Gg

5-3. Projected Effects of Measures

5-3-1. Energy (Fuel Combustion)

* As with carbon dioxide and methane, projections of nitrous oxide emission for fiscal 2000 are based on the outlook cited in the "Long-term Energy Supply and Demand Outlook."
* If all of the energy-conservation measures incorporated in the "Outlook" are fully implemented by all parties concerned, nitrous oxide emissions in fiscal 2000 will be reduced by approximately 2 Gg as compared with a scenario in which no measures are implemented.

5-3-2. Industrial Processes

Nitrous oxide is produced as a by-product in the manufacture of adipic acid. Because no specific figures are available concerning the amount of adipic acid that will be produced in fiscal 2000, and because this makes it difficult to project what effects policies in this category might have, the effects have not been considered here.

5-3-3. Agriculture

* Activity data in the "Agriculture" category are based on values cited in the "Long-term Prospects for the Demand and Production of Agricultural Products." Projections based on these values indicate that nitrous oxide emissions in the "Agriculture" category in fiscal 2000 will essentially be the same as in fiscal 1990.
* Although nitrous oxide emission control measures (such as promoting the use of slow-release fertilizer) are planned for "Agriculture" category, their effects are not considered here because it is difficult to make quantitative projections at this time.

5-3-4. Waste

* Projections of nitrous oxide emissions from "Waste" are based on estimates of the total amount of waste that will be generated in fiscal 2000. For municipal waste, the 30% reduction target for fiscal 2000 outlined in the Report of the Living Environment Council's Special Committee for Waste Reducing and Recycling was used, based on the assumption that serious efforts will be made to thoroughly recycle paper waste, reduce excessive packaging, and limit the use of throw-away containers.
* Japan has actively developed incineration as a means of reducing waste amounts and stabilizing waste disposal. Although this measure has resulted in increased nitrous oxide emissions, it has also contributed to curb methane emissions.